A McGRAW-HILL PUBLICATION • PRICE ONE DOLLAR

DECEMBER 5, 1958

electronics

engineering issue

Thermoelectric Cooling ...p 80

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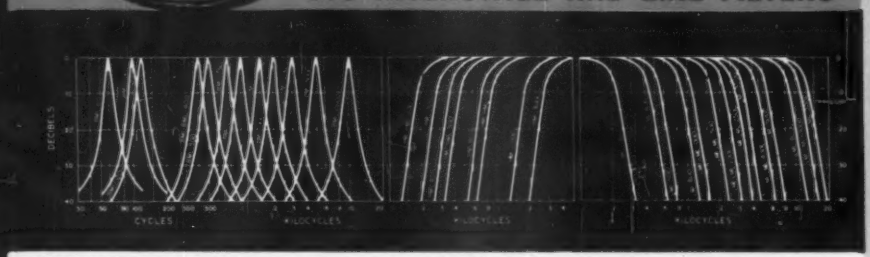
FILTERS

HERMETICALLY SEALED TO MIL-T-27A & MIL-F-18327

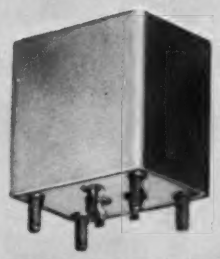
FOR ALL APPLICATIONS FROM STOCK

UTC INTERSTAGE AND LINE FILTERS



STOCK TYPES
(number in figure is cycles)

BMI-60	BMI-10000	LMI-800	HML-300
BMI-100	HMI-200	LMI-1000	HML-500
BMI-120	HMI-400	LMI-1500	HML-1000
BMI-400	HMI-500	LMI-2000	LML-1000
BMI-500	HMI-800	LMI-2500	LML-1500
BMI-750	HMI-1000	LMI-3000	LML-2000
BMI-1000	HMI-2000	LMI-4000	LML-2500
BMI-1500	HMI-3000	LMI-5000	LML-4000
BMI-2000	LMI-200	LMI-10000	LML-8000
BMI-3000	LMI-400	BML-400	LML-10000
BMI-4000	LMI-600	BML-1000	LML-12000
BMI-5000		HML-200	



This standardized group of filters covers most popular filter applications and frequencies. Units are in compact, drawn, magnetic shielding cases... 1 3/16 x 1 1/16 base, 1 3/8 high for BMI, LMI, BML; others 2 1/2 high. There are six basic types:

BMI band pass units are 10K input, output to grid 2:1 gain. Attenuation is approximately 2 db at 3% from center frequency, then 40 db per octave.

HMI high pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at .67 cut-off frequency.

LMI low pass units are 10K in and out. Attenuation is less than 6 db at cut-off frequency and 35 db at 1.5 cut-off frequency.

HML high pass filters are same as HMI but 500/600 ohms in and out.

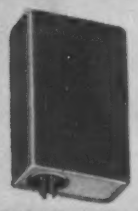
LML low pass filters are same as LMI but 500/600 ohms in and out.

BML band pass units are same as BMI but 500/600 ohms input, output to grid, 9:1 gain.

UTC TELEMETERING BAND PASS FILTERS

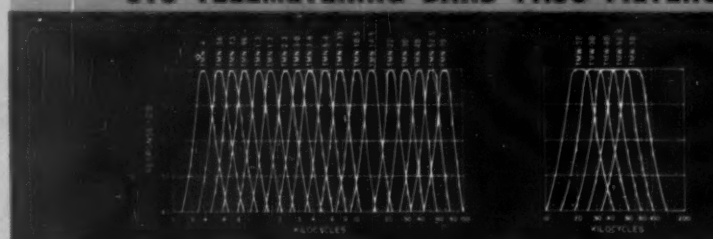
STOCK TYPES
(number in figure is KC)

TMN-.4	TMN-2.3	TMN-14.5	TMW-22
TMN-.56	TMN-3.0	TMN-22	TMW-30
TMN-.73	TMN-3.9	TMN-30	TMW-40
TMN-.96	TMN-5.4	TMN-40	TMW-52.5
TMN-1.3	TMN-7.25	TMN-52.5	TMW-70
TMN-1.7	TMN-10.5	TMN-70	



TMN-.4 thru TMN-1.7
11/16 x 1 5/32 x 2 inches
Weight ____3.5 oz.

TMN-2.3 thru TMW-70
23/32 x 23/32 x 1 3/8 inches
Weight ____1.2 oz.

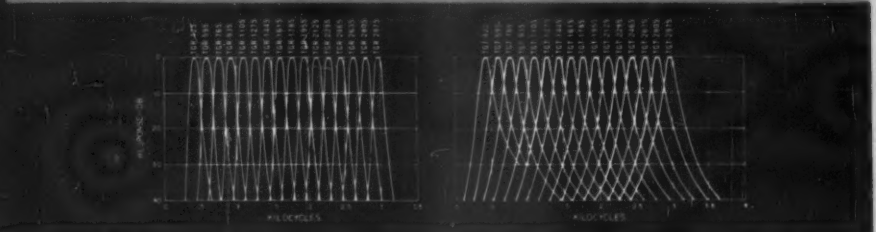


UTC standard telemetering filters provide extreme miniaturization with maximum stability, a complete set of 18 filters taking 19 cubic inches. They are 100K in and out and have an insertion loss of less than 6 db, 4 pin header for small Winchester socket.

TMN units are within 3 db at ± 7.5% of center frequency... down more than 18 db at ± 25%... more than 40 db beyond 1.75 and .58 center frequency.

TMW are within 3 db at ± 15% of center frequency... down more than 20 db at ± 50%... more than 40 db beyond 2.5 and .4 center frequency.

UTC TELEGRAPH TONE CHANNEL FILTERS



STOCK TYPES
(number in figure is cycles)

RECEIVING

TGR-425	TGR-1785
TGR-595	TGR-1955
TGR-765	TGR-2125
TGR-935	TGR-2295
TGR-1105	TGR-2465
TGR-1275	TGR-2635
TGR-1445	TGR-2805
TGR-1615	TGR-2975

TRANSMITTING

TGT-425	TGT-1785
TGT-595	TGT-1955
TGT-765	TGT-2125
TGT-935	TGT-2295
TGT-1105	TGT-2465
TGT-1279	TGT-2635
TGT-1449	TGT-2805
TGT-1615	TGT-2975

TGT CASE
1 1/2 x 1 1/2 x 2 1/2 in. 8 oz.

TGR CASE
1 1/2 x 1 1/2 x 4 1/4 in. 15 oz.

These band pass filters for multiplex transmitting and receiving provide maximum stability in miniature sizes. Both receiving and transmitting types are 600 ohms in and out, and employ 7 terminal header for sub-miniature 7 pin socket.

TGR receiving filters are within 3 db at ± 42.5 cycles from center frequency... down more than 30 db at ± 170 cycles... down more than 15 db at adjacent channel cross-over.

TGT transmitting filters are within 3 db at ± 42.5 cycles from center frequency... down more than 16 db at ± 170 cycles... down more than 7.5 db at adjacent channel cross-over.

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electronics engineering issue

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electronics

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Temp. °C	MΩ X μF
125	300 (min.)
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ONE BEST BET in 1959

Beginning in January, ELECTRONICS will have the same editorial format each week.

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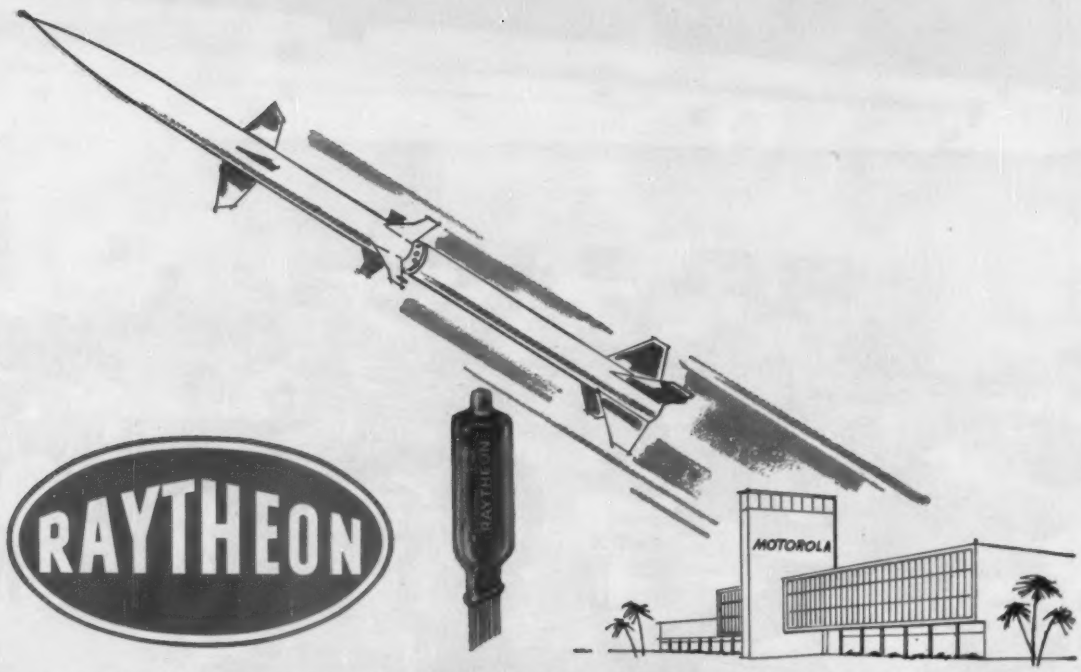

RELIABLE SUBMINIATURE TUBES

averaged one-third the rejection rate of all other tubes used in a Missile Guidance System at MOTOROLA INC.

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Raytheon *Flat Press* Reliable Subminiature Tubes averaged 0.9% removals in critical Terrier missile system tests compared to 2.8% for all other types. Raytheon *Flat Press* construction provides superior mechanical features including:

longer and stronger glass-to-lead wire seal
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RAYTHEON RELIABLE SUBMINIATURE TUBES For Guided Missile, Military and All Other Critical Applications
TYPICAL CHARACTERISTICS

TYPE	DESCRIPTION	Vibration Output* (maximum) mVac	Vibration Output** peak to peak mv	Heater Volts	Heater mA	Plate Volts	Plate mA	Cathode Bias Resistor ohms	Screen Volts	Screen mA	Amplification Factor	Mutual Conductance μmhos
CK5702WB	Video Amplifier, Pentode	50	240	6.3	200	120	7.5	200	120	2.6	—	5000
CK5703WB	High Frequency Triode	10	50	6.3	200	120	9.4	220	—	—	25.5	5000
CK5704WA	High Frequency Diode	—	25	6.3	150	Max. inverse peak = 460 volts; max. I_0 = 10 mA						
CK5744WB	High Mu Triode	15	75	6.3	200	250	4.2	500	—	—	70	4000
CK5783WB	Voltage Reference	20	—	Operating voltage approximately 85 volts between 1.5 and 3.5 mA								
CK5784WB	RF Mixer Pentode	75	300	6.3	200	120	5.5	230	120	4.1	—	3200
CK5787WB	Voltage Regulator	20	—	Operating voltage approximately 98 volts between 5 and 25 mA								
CK6247WA	Low Microphonic	2.5	25	6.3	200	250	4.2	500	—	—	60	2650
CK6533WA	Low Microphonic Triode	1.0	15	6.3	200	120	0.9	1500	—	—	54	1750

Each type is electrically and mechanically interchangeable with earlier versions of the same basic type.
Developed under Navy sponsorship.

Bulb temperature ratings to 265°C

*15g, 40 cps, fixed frequency
**15g, 30 to 1000 cps sweep

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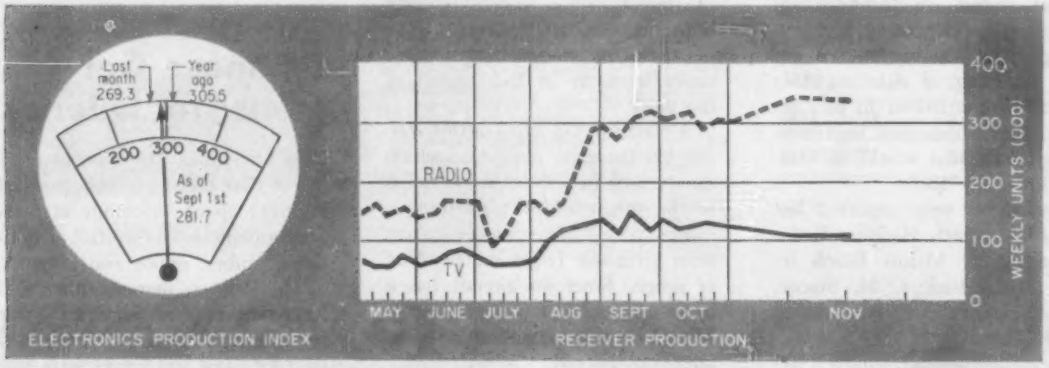
ELECTRONICS NEWSLETTER

PACKAGED MASER SYSTEM with potential uses in space electronics, long-range radar and aircraft is about 18 months from prototype completion. Prediction comes from Sylvania Research Laboratories vice president Robert M. Bowie. He said recently that Sylvania's concept of a packaged maser system would include a small, built-in cooling system, and a small permanent magnet instead of the huge electromagnets now used in laboratory systems. Bowie added that "there are a number of problems still to be solved before we can demonstrate a working miniaturized system." Goal, he explained, is a simple, rugged system that could be operated by a serviceman and "accomplish feats of detection not dreamed of with present-day radar." The maser, he said, would increase the range of a conventional radar system from two to seven times.

NUCLEAR POWER PLANT that can be transported by air and set up as the main power source at remote radar stations is just announced by the Atomic Energy Commission. Prototype of the unit, the Argonne Low Power Reactor (ALPR), has been completed at the AEC's National Reactor Testing Station in Idaho. Instruments, controls and associated remote transmitters and devices were supplied by Leeds & Northrup. The ALPR, which can supply 200 kw of electricity and 400 kw of space heat, is intended to operate radar equipment and warm installations. Overall unit cost is about $2 million, of which one fourth is for reactor components, instrumentation and assembly.

BRITISH COMPUTERMAKER EMI Electronics is entering the U.S. market with a giant, high-speed, general-purpose electronic computer. The machine, EMIDEC 2400, uses transistor diode logic units and circuit elements mounted on plug-in printed circuit panels, switches in 2/10 of a microsecond and executes instructions in 25/40 microseconds. Arthur Hoffman, president of L. H. Hoffman, Westbury, L. I., which represents the British firm, said a unit would be ready in June or July for delivery. He said the U.S. Government had expressed interest in the machine, which consists of 53 racks and is about half a block long; British Ministry of Defense, he said, was getting the first unit. Cost, including associated data-processing gear, is about $2.5 million, he said.

RADIO TELESCOPE with 160,000 sq ft of receiving area is being built by the University of Illinois with a $233,000 Navy grant. Site is 35 miles east of the Urbana-Champaign campus. The trough-shaped reflector will be 600 ft long; trough will be 400 ft wide and 65 ft deep.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Nov. 14, '58	Nov. 7, '58	Nov. 15, '57
Television sets, total	112,202	111,554	137,263
Radio sets, total	364,943	344,204	442,416
Auto sets	113,309	117,585	152,541

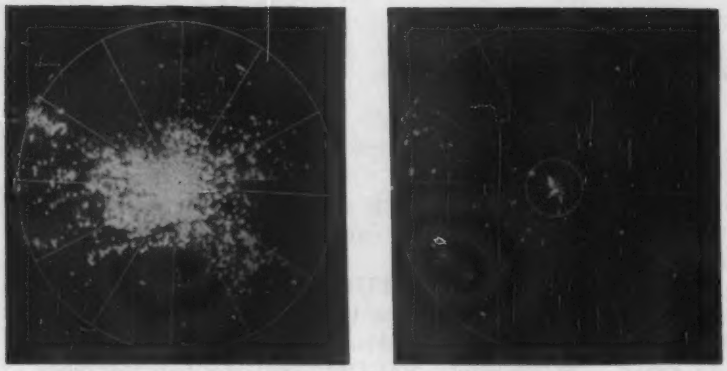
STOCK PRICE AVERAGES

(Source: Standard & Poor's)	Nov. 19, '58	Nov. 12, '58	Nov. 20, '57
Radio-tv & electronics	69.18	68.84	42.65
Radio broadcasters	75.67	76.88	52.00

FIGURES OF THE YEAR

Totals for first nine months

	1958	1957	Percent Change
Receiving tube sales	291,718,000	341,663,000	−14.6
Transistor sales	30,387,277	18,842,300	+61.3
Cathode-ray tube sales	5,844,665	7,308,552	−20.0
Television set production	3,572,189	4,589,164	−22.2
Radio set production	8,178,821	10,764,454	−24.0
TV set sales	3,468,090	4,452,041	−22.1
Radio set sales (excl. auto)	4,903,676	5,840,372	−16.0



Radar shows daytime bird distribution (left), then same scene after applying bird-removing circuit. Except where many birds are feeding together, each remaining dot represents a plane

Isolating Radar 'Angels'

New circuit, result of two-year study, helps pinpoint sources of spurious radar echoes

MOST RADAR "angels" observed at coastal sites are caused by birds, reports an MIT Lincoln Lab group which recently completed exhaustive study at So. Truro, Mass., on Cape Cod.

Development of "bird-removing circuit" helped pinpoint source of spurious radar echoes, much-discussed obstacle to aircraft tracking (ELECTRONICS, p 140, March 14).

Research project resulted in: Design of circuit which clears ppi scope by removing birds while retaining radar's ability to see aircraft; gathering of data on daily and seasonal variations in bird activity. Latter indicates high-powered ground radar would be valuable bird-study tool.

Conclusions were reported last month to Seventh Weather Radar Conference at Miami Beach by R. E. Richardson, J. M. Stacey, H. M. Kohler and F. R. Naka of Lincoln Lab.

Researchers using L-band (1,300 mc) surveillance radar discovered that natural overwater targets covered much of first 40 miles on ppi display. On many Spring and Fall nights, ppi was blanketed by such targets to more than 50 miles.

Evidence pointed consistently to birds, and theory was strengthened by correlated information on bird habits and by distributions observed on low-altitude aircraft flights.

Additional confirmation came when the research group developed a circuit applying time-varying gain to radar.

Richardson pointed out at the conference that radar energy return from a target which remains in the same region of antenna gain pattern and is small compared to beam cross-section, varies inversely as the fourth power of the range to the target. Since received voltage is proportional to the square root of the energy, received voltage varies inversely as the square of the range.

A time-varying gain-control voltage was therefore developed which causes radar gain to be proportional to the square of time after transmitter pulse. This makes return from given-size target independent of range. Since an aircraft has a larger cross-section, it is possible to adjust gain to remove birds without removing aircraft.

Experience has shown, MIT researchers said, that a setting which removes targets 30 db above noise at 20 nautical miles causes ppi scope face to be clean, but allows tracking of small aircraft.

Much of the meteorological work with radar has been done at K-band, where wavelength is comparable to insect dimensions, and there appears to be evidence that at least some of targets are due to insect returns. At L-band, however, insects are in Rayleigh region, and should have negligible radar cross-section, team reported.

Early phases of two-year experiment were performed with a radar whose lower beam, having a vertical beamwidth of 3 deg, just "scrapes" horizon at its lower 3 db level. Upper beam was positioned just above lower beam. Unidentified targets were visible on lower beam, but were not observed on upper. In later portions of experiment, single fan beam was used.

A powerful tool in identification of targets was the bipolar coherent video out of the i-f phase detector, as viewed on an A-scope. A return is coherent if there is a systematic pulse-to-pulse relationship of the r-f phase of received signal compared to transmitted signal. Antenna was stopped and allowed to searchlight at an azimuth containing desired targets.

Also at weather radar conference, papers were presented on cloud and precipitation physics, sferics, atmospheric physical conditions associated with microwave propagation, an isoecho contouring device to predict sudden changes in ceiling and visibility, and radar analysis of severe storms.

Japanese Get Transistor Queries

TOKYO—SEVERAL Japanese firms report that they have just received inquiries about "a couple of hundred million dollars worth" of transistors, tubes, radios and tv parts.

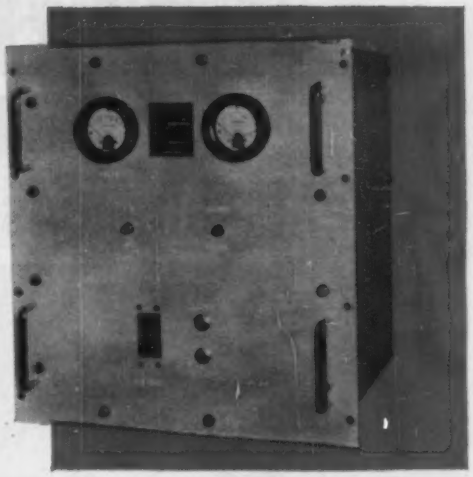
The Japanese manufacturers told ELECTRONICS the inquiries came from large U. S. firms. They said delivery dates and prices were still subject to negotiations.

Japanese firms and the orders each is negotiating are: Hitachi—7 million tubes and several hundred million transistors; Toshiba—8.2 million tubes and several hundred million transistors; Nichiden—3 million tubes. No breakdown on transistor radios and tv parts in-

(Continued on p 12)

PERKIN

FOR THE FIRST TIME...28V AT 100 AMPERE
transistorized, virtually transient-free
DC POWER SUPPLY



MODEL MTR28-100

A MAJOR BREAK THROUGH IN DC POWER!!

Realizing a definite need for dynamically regulated D.C. Power in high current capacities, Perkin Engineering has pioneered the development of a line of units headed by 100 ampere, completely transistorized, power supply, with excellent transient regulation which is a "must" when powering voltage sensitive equipment such as transistorized inverters, converters, etc. This unit suppresses line and load transients to a very low level virtually eliminating voltage "overshoot" and "undershoot" common with more conventional supplies.

UNIQUE FEATURES OF MODEL MTR28-100

- COMPLETELY TRANSISTORIZED
- EXCELLENT DYNAMIC (TRANSIENT) REGULATION
- LOW RIPPLE
- SHORT CIRCUIT PROOF
- AUTOMATIC CURRENT LIMITING
- SILICON POWER RECTIFIERS
- FAST RESPONSE TIME
- REMOTE SENSING
- SILICON ZENER DIODE REFERENCE ELEMENT

MODEL MTR060-5

MODEL MTR28-10

SPECIFICATIONS ON MTR28-100

AC INPUT:	208/230 OR 460 V. ± 10% 3 PHASE, 60 CPS
D.C. OUTPUT:	24-32 V @ 100 A
REGULATION:	
STATIC:	±0.1% LINE; ±0.1% LOAD
DYNAMIC:	±0.5% LINE; ±2 V. LOAD
RIPPLE:	20 MV RMS MAX.
DYNAMIC IMPEDANCE:	0.025 OHMS MAX.
RESPONSE TIME:	1 MILLISECOND MAX.

OTHER UNITS AVAILABLE WITH COMPARABLE SPECIFICATIONS

MODEL NO.	D. C. OUTPUT VOLTS	AMPS
MTR060-1	0-60	1
MTR060-5	0-60	5
MTR636-15	6-36	15
MTR636-30	6-36	30
MTR28-2	24-32	2
MTR28-10	24-32	10
MTR28-30	24-32	30

PERKIN ENGINEERING CORPORATION

345 KANSAS STREET, EL SEGUNDO, CALIFORNIA • OREGON 8-7215

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New England Area Office: 46 Amesbury, Lawrence, Massachusetts • MUrdock 3-3252

Sales offices in principal cities throughout the country.

PERKIN AND AC LINE REGULATORS

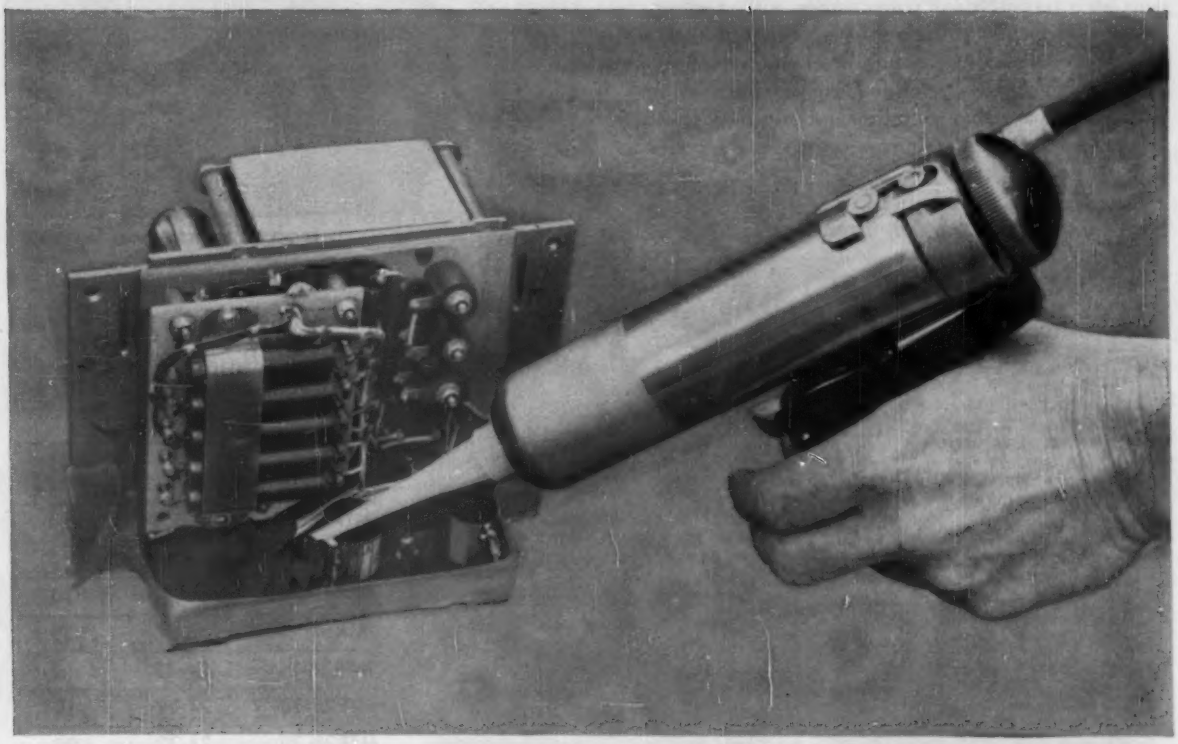
PERKIN

Design better products with

SILASTIC RTV

SILICONE RUBBER

...seals and cushions delicate circuits



High impedance circuits in Northrop's Snark missile are coated with Silastic RTV for protection against moisture and vibration at temperature extremes. Silastic RTV is easy to apply . . . vulcanizes at room temperature.

Sensitive electronic components are sealed against moisture and cushioned against vibration with a coating of Silastic* RTV, the Dow Corning silicone rubber. Silastic RTV forms a rubbery silicone solid in 24 hours at room temperature. Stays resilient from —70 to 260 C. This "do-it-yourself" material is used for a wide range of encapsulating, potting and caulking applications. Write for free sample and complete information.

If you consider ALL the properties of a silicone rubber, you'll specify SILASTIC.

*T.M.REG.U.S.PAT.OFF.

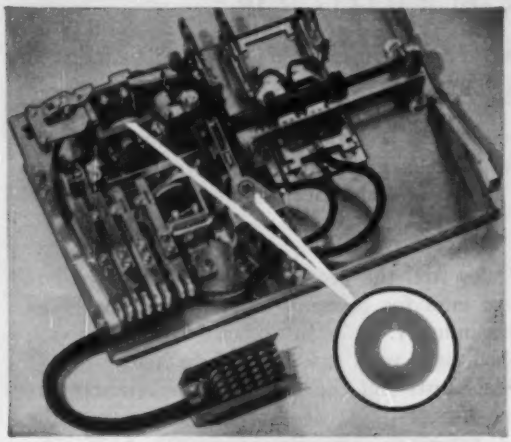
TYPICAL PROPERTIES OF SILASTIC RTV

Temperature range, °C . .	—70 to 260C
Dielectric strength, volts/mil . .	300 to 500
Surface resistivity at 50% Relative humidity, ohms . .	2.8×10^{13}
Dielectric constant, 10^5 cycles per second	2.5
Dissipation factor, 10^5 cycles per second	0.003

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

Dow Corning Silicone Dielectrics



Stromberg-Carlson telephone switch insulator

SILICONE-GLASS LAMINATES INCREASE LIFE AND DEPENDABILITY

Laminates made by bonding glass cloth with Dow Corning silicone resins have high arc resistance, low loss factor, low moisture absorption, excellent retention of dielectric properties at high temperatures. Strong, lightweight—produced by leading laminators.

CIRCLE 104 READERS SERVICE CARD

SILICONE FLUIDS PROTECT ASSEMBLIES FROM MOISTURE

Southwestern Industrial Electronics seismographs

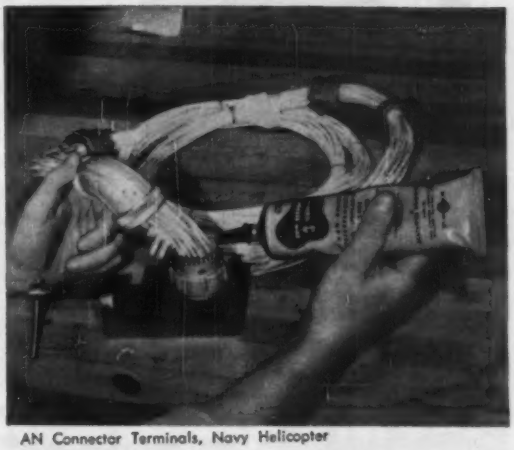
A protective film of Dow Corning 200 Fluid spray coated on electronic assemblies protects terminals, clips, switches and other exposed connections from the harmful effects of condensation. Glass and ceramic insulators coated with silicone fluid have low current leakage and a high degree of surface resistivity, even under very humid conditions.

CIRCLE 105 READERS SERVICE CARD

SILICONE COMPOUND PREVENTS ARCS, GROUNDS, SHORTS

Nonmelting, nongumming Dow Corning 3 Compound stays in place . . . provides an effective, moisture-proof dielectric seal for all types of electronic equipment. As a potting or filling material for electronic components and assemblies, silicone compounds flow into place with gentle pressure . . . have a serviceable temperature range of —40 to 205 C. Free sample available.

CIRCLE 106 READERS SERVICE CARD



AN Connector Terminals, Navy Helicopter

For further information on these products write Dept. 4812

quiries is available right now.

Kenichiro Komai, Hitachi's managing director, said Japanese production facilities are now big enough to meet such huge orders.

Transistor output in Japan passed the 3-million-a-month mark in October, with some sources predicting a 35-million total for the year.

The Ministry of International Trade and Industry's five-year electronics expansion program calls for 70 million units a year by 1962. However, last month a spokesman for the Japan Electronics Industry Association said that, in reality, production "will be hitting a couple of hundred million by then." Statement was made before inquiries from U.S. firms were disclosed.

About 95 percent of current production goes into transistor radios. Japanese transistor radio exports to the U.S. this year will reach an estimated $15 million, five times more than last year.

It's understood that transistor radio production last month hit 500,000 units, while that many were being exported to the U.S. and others. Of these, 300,000 are being turned out by the same firms that make transistors—Toshiba, Nihon Electric, Sony, Hitachi, Kobe Industrial and Matshishita.

Magnetic Rod May Speed Computers

Inserting magnetic rod elements into memory assembly. Chalkboard drawing shows rod design

TINY magnetic device which switches current at a speed of 4 millimicroseconds and can also serve as a storage element was re-

WASHINGTON OUTLOOK

MILITARY ELECTRONICS PRODUCERS may encounter Federal action to push up the industry's minimum wage rate.

Certain aircraft manufacturers and two major labor unions in the industry have urged the Labor Dept. to include electronics firms making missiles in a proposed Walsh-Healey Act survey of aircraft manufacturing.

Under the Walsh-Healey Act, the Secy. of Labor is authorized to set legal minimum wage rates for government contractors based on prevailing wages in the industry. Current official rate for aircraft manufacturing, established eight years ago, is $1.05 an hour.

The Intl. Assn. of Machinists and the United Auto Workers—the two major unions in the aircraft industry—claim that a survey of the industry would show a prevailing minimum of roughly $1.90. An unofficial estimate of electronics' prevailing minimum hourly wage is about $1.60.

As of now, the electronics industry—including missile production—is not formally covered by a Walsh-Healey wage determination.

The Aircraft Industries Assn. and the two unions propose that the Walsh-Healey definition of the aircraft industry be expanded to cover missiles and completed end-product electronic systems incorporated in missiles.

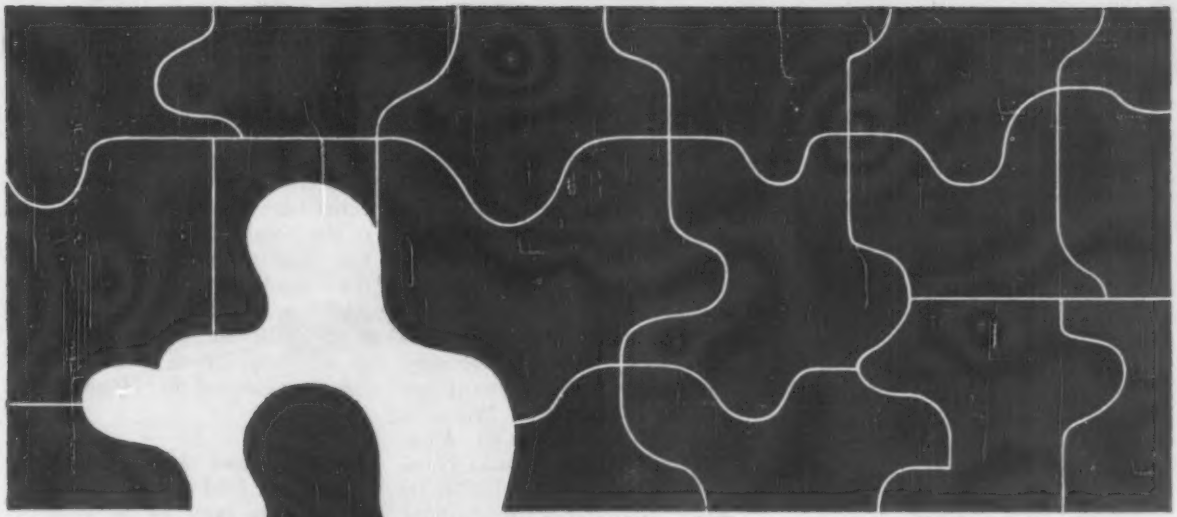
The Electronics Industries Assn. objects to this proposal. EIA says the aircraft industry definition should stand as is, and that a separate missile industry be defined or be included with electronics.

The Labor Dept. has proposed a new definition as a compromise between the two positions. This would lump the assembly and manufacture of missiles in with aircraft, but would exclude the manufacture of electronic missile subsystems.

- **The Defense Dept.** budget for fiscal 1960, now being prepared is expected to show research and development expenditures of well over $6 billion, compared to this year's $2.3 billion. But this won't mean R&D spending is being trebled.

  Next year, for the first time, Pentagon budget officials plan to include in the R&D budget breakdown costs for prototype fabrication and testing and evaluation of new weapons—expenses which up to now have been classified as "procurement and production." Such expenditures now run to almost $4 billion a year.

  The Pentagon has long been the target for criticism that the military services do not support enough research and development. Military officials have argued, in defense, that the military R&D budget fails to tell the full story of military support for scientific effort. So the budget layout is being revamped to include under R&D expenditures everything related to weapon development.



Puzzled by ground loop problems? How to rescue microvolt signals from volts of noise?

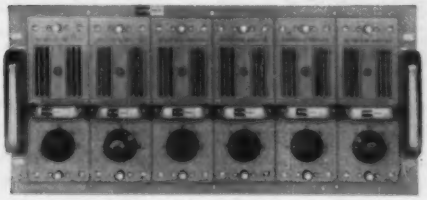
HERE'S WHY KIN TEL'S DIFFERENTIAL DC AMPLIFIERS FIT IN INSTRUMENTATION SYSTEMS

160 db DC, 120 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ .05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 120 cycle bandwidth ■ Integral power supply

These are just a few of the many outstanding features of the Model 114A differential DC amplifier . . . features that make this amplifier *really work* in instrumentation systems...features that will help solve *your* instrumentation problems today.

Ideal for thermocouple amplification, the 114A eliminates ground loop problems; allows the use of a common transducer power supply; permits longer cable runs; drives grounded, ungrounded or balanced loads, and can be used inverting or non-inverting.

For additional information and technical literature on this exceptional instrument, write or call KIN TEL – the world's largest manufacturer of precision, chopper-stabilized DC instruments.



KIN TEL 114A differential DC amplifiers ...convenient, interchangeable plug-in mounting in either 6-amplifier 19" rack mount modules or single-amplifier cabinets.

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Representatives in all major cities

KIN TEL
A Division of Cohu Electronics Inc.

cently announced by the National Cash Register Co.

The device is a glass rod about 15 thousandths inch in diameter with a magnetic coating and tiny windings of wire around it. NCR research vice president Robert G. Chollar describes it as "one of the most significant recent advances in digital computer technology."

Chollar said that thousands of rods could be linked within a small space to solve commercial data processing or space-vehicle problems with "unprecedented speed." Rod element, he said, can be used both in word-ordered and coincident current memory circuits.

NCR says the rod will have these implications for the space age: It will permit missile or satellite navigation with smaller power sources; increase the useful range of these vehicles; and increase dependability of vehicles in high temperatures.

Firm asserts that use of the rod as both logical switch and storage element will reduce the number of semiconductors needed in a computer, with all switching being done by the rods. It says a rod network the size of a cigarette package could store 8,000 bits of information.

Only 20 thousandths watt is required to store an information "bit" on one rod, and 5,000 rods could operate on the energy used to light a 100-watt bulb.

Other details disclosed by NCR:

- Rod has operated in the laboratory on the coincident current mode from −100 C to +200 C; in word-ordered mode this range can be extended upward.
- Device has been switched continuously at 5-mc repetition rate without adverse heating effects.
- Hysteresis loop on unit's magnetic coating is square, showing ratios of better than 0.95.
- It's possible to wind 10 bit-positions per linear inch along the rod without mutual interference. Fine wire windings are placed on the rod like a solenoid, with succesive windings superimposed. Present packing density is 1,000 bits per cu in.

The company is investigating such applications as: high-speed memory with one microsecond cycle time; shift registers and counters in the 2 to 5-mc range.

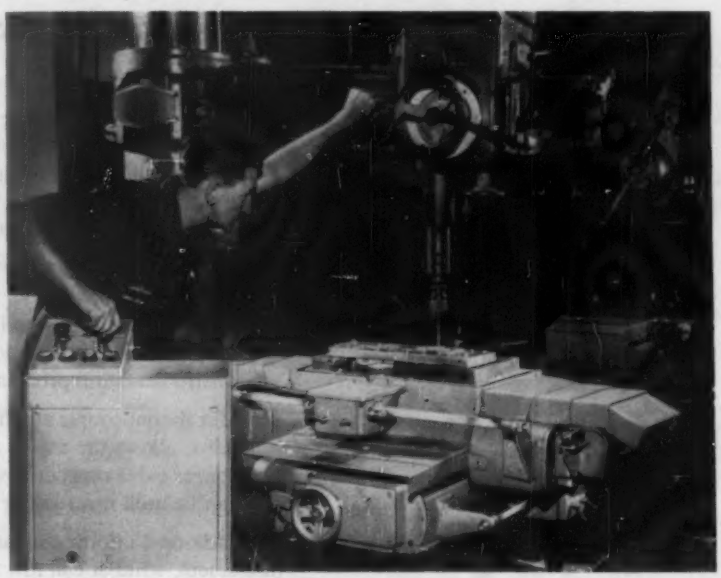
MILITARY ELECTRONICS

• **Navy is studying** feasibility of scaling up findings from small research rocket flights to predictions for the Polaris IRBM. The program calls for three research rockets, developed by Atlantic Research Corp.

Arcon, sponsored by BuOrd and the Naval Research Laboratory, will carry a 40-lb instrument payload to an altitude of 70 mi, or a 10-lb payload to 100 mi. Arcas, sponsored by the Office of Naval Research, will carry 12 lbs to nearly 40 mi. Third rocket, Iris, scheduled for completion early in 1959, is designed to carry a 100-lb instrument package 200 mi. The three rockets combined could take a payload of instruments up 1,000 miles or perhaps even higher.

Electronic gear at present is either fabricated in the naval labs or else bought by Navy from outside industry. Atlantic Research does much of the installation. Navy may conceivably decide later to give the entire responsibility to one firm. Total business to date represents well over $1 million.

• **Army hopes** to fire a five-ton satellite to a fixed position, 22,000 mi above the earth, by late 1960, according to Roy W. Johnson, director of the Advanced Research Projects Agency. Satellite equipment will probably include a television camera.



Automatic control unit positions milling-machine table

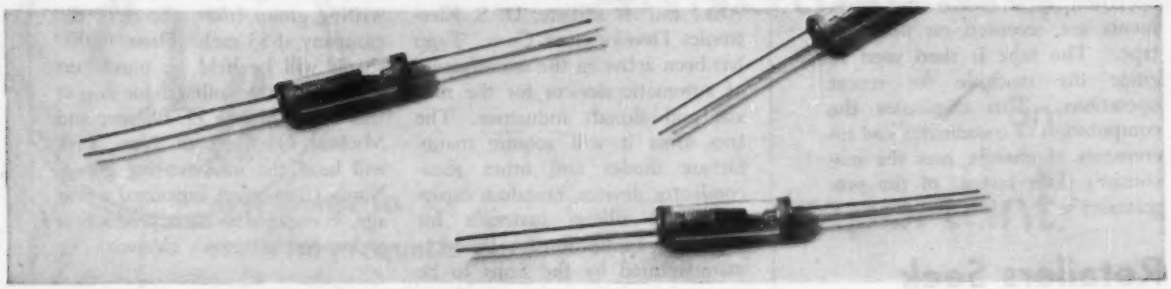
Control System Learns Jobs

WEST COAST electronics experts saw a device this month that produced a complicated cam in 18 minutes. Normal production time for this part is 17 hours.

The new unit, called the Micro-Path control system, was developed by Topp Industries, Los Angeles. Firm predicts that it will speed the realization of the completely automatic factory by ten years.

System incorporates a high-speed memory and electronic network that effects responses accurate to 0.002 in. Proposed applications of the Micro-Path are for machine

HUGHES THERMAL RELAYS



FOR RELIABILITY

IN GUIDED MISSILES

Hughes now makes commercially available a completely reliable single action switch. Used in the Falcon, field proven as a reliable missile, this Hughes relay is engineered to meet the most exacting of requirements.

With unusual speed of action, firing signal triggers the release of constrained contact... contact closes upon fixed contact point... switch circuit becomes permanently closed.

In a typical application, 3.0 volts DC applied to a firing circuit of 1.2 ohms fires within 0.3 seconds.

For additional information please write: Hughes Products, Marketing Department, International Airport Station, Los Angeles 45, California.

SPECIFICATIONS

MECHANICAL—Body Size: Maximum diameter 0.252"; length .920". Total weight: Less than 0.1 oz.

ELECTRICAL—**Before Firing:** Insulation resistance is greater than 200 megohms. Minimum breakdown voltage 600 volts.

Firing: 2 volts minimum required. Actual voltage dependent upon closing time desired.

After Firing: Circuit resistance less than 0.3 ohm.

ALTITUDE—Any.

OPERATING TEMPERATURE: −55°C to +125°C.

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS
OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS

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tools including lathes, milling machines, drills and routers. Other possibilities exist in transfer equipment and other moving areas of large factory operations.

To "teach" the machine, a machinist guides it once through its operation cycle, while its movements are recorded on magnetic tape. The tape is then used to guide the machine for repeat operations. This eliminates the computation of coordinates and increments of change, uses the machinist's skills instead of the programmer's.

Retailers Seek Electronic Aid

LAST WEEK a call went out for low cost electronic equipment to meet department store needs.

Ethel Langtry, director of the National Retail Merchants Association's Retail Research Institute and a member of NRMA's Electronics Committee, said the association wants to hear from electronics manufacturers interested in retailer equipment problems.

More than 2,000 stores have annual sales exceeding $1 million, Miss Langtry said, pointing out they constitute a potentially big market for the electronic industry. To date these stores have purchased little electronic equipment to meet their data-recording and processing needs.

Keenness of competition, rising labor costs, spreading branch operations and increasing complexity of credit operations have made equipment for reducing operating costs a major issue with storekeepers.

Purpose of the Electronics Committee is to develop specifications for equipment. Framework is a monthly meeting at which equipment makers are questioned about their products by retailers, and retailers inform manufacturers about equipment aims, problems and successes.

Strongest store interest is in equipment for processing accounts receivable and auditing sales. Many stores report interest in equipment for merchandise control; others are interested in stock control and department statements.

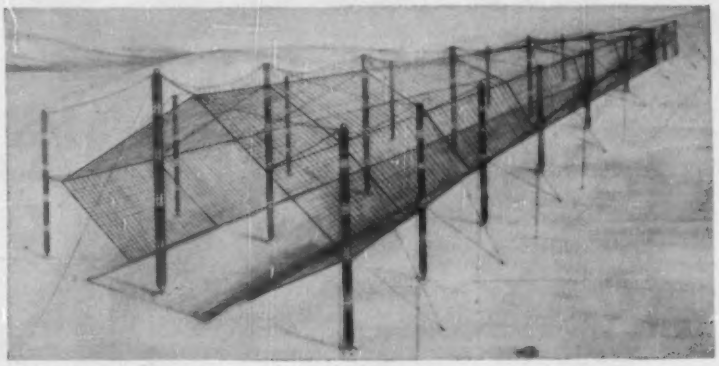
FINANCIAL ROUNDUP

• **Topp Industries** of Los Angeles plans to acquire **U. S. Semiconductor Products** of Phoenix, Ariz., and its affiliate, **U. S. Electronics Development Corp.** Topp has been active in the manufacture of automatic devices for the missile and aircraft industries. The two firms it will acquire manufacture diodes and other semiconductor devices, tantalum capacitors and silicon materials for infrared applications. Products manufactured by the firms to be acquired lend themselves to miniaturization, particularly in industry and space technology. Proposal for exchange of stock of Topp and U. S. Semiconductor is being prepared for submission to stockholders.

• **Narda Ultrasonics,** Mineola, Long Island, N. Y., files registration statement with SEC for 100-000 shares of common stock. Sixty thousand shares are to be offered for public sale by firm's controlling stockholder, **Narda Microwave Corp.** Additional 40,000 shares represent purchases of 5,000 shares by each of eight firms in the underwriting group from officers of the company at $3 each. These 40,000 shares will be held by purchasers and will not be offered for sale at this time. Milton D. Blauner and Micheal G. Kletz of New York will head the underwriting group. Narda Ultrasonics, organized a year ago, is engaged in mass production of low-cost ultrasonic cleaners.

• **Scientific-Atlanta** offers its common stockholders rights to subscribe to 6,500 additional shares of common stock at $5 per share. One new share can be purchased for each 20 held. Firm makes electronic test equipment and plastic components. No underwriting is involved.

• **Thompson Products** name is changed to **Thompson Ramo Wooldridge** as merger of **Ramo-Wooldridge Corp.** into Thompson Products goes into effect.



High-frequency horn antenna under construction for Army Signal Corps

Army To Test Giant Antenna

ARMY Signal Corps will test a new antenna technique to try for higher directivity in its strategic short-wave communications.

Signal Corps contractor Developmental Engineering Corps., Leesburg, Va., is now building a giant tapered-aperture horn at La Plata, Md., to check out the idea that such horns can be as efficient in the short-wave spectrum as they are in

(Continued on p 20)

CIRCLE 10 READERS SERVICE CARD→

ANNOUNCING

an

Important

Change

in response to
the many requests
for a name indicative
of the industry's fastest growing
microwave company,
F-R Machine Works, Inc.
will be known
as FXR, Inc.
This new name, our trademark, continues
to symbolize the exceptional blend
of engineering and craftsmanship
that has established
FXR as the leader
in microwave equipment
and high-power
modulators.

Contact our local
sales representative
in your area
for details.

FXR, Inc. formerly F-R MACHINE WORKS, Inc.

DESIGN • DEVELOPMENT • MANUFACTURE

PRECISION MICROWAVE EQUIPMENT
•
HIGH POWER MODULATORS
•
RADAR COMPONENTS
•
ELECTRONIC TEST EQUIPMENT

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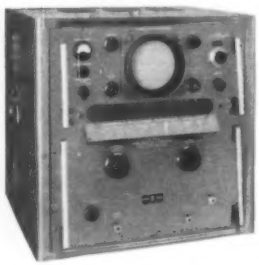
MICROWAVE INSTRUMENTATION

Coming Soon . . .
New printed circuit Standing Wave Amplifier.

BROADBAND SPECTRUM ANALYZER, 701

Type L701A: 950 to 2000 Mc/s (Fund.)
Type S701A: 1900 to 4000 Mc/s (Fund.)
Harmonic Operation: to 16,000 Mc/s
Swept IF: 7 Kc and 50 Kc
Sweep Width: 50 Mc
RF Attenuator: 100 db Range
Video Markers



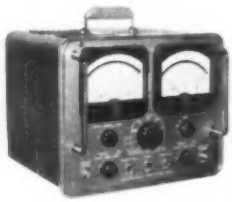
SIGNAL SOURCES, 771, 772

Type L771B: 950 to 2000 Mc/s
Type S771B: 1900 to 4000 Mc/s
Type C772A: 3950 to 8200 Mc/s
Type X772A: 7000 to 11,000 Mc/s
Output Power: 50 mw (average)
Direct Reading Frequency Dial: 1%
Internal Modulation: Pulsed, Square Wave, C.W.
Integral RF Level Set Attenuator

UNIVERSAL RATIOMETER, 811

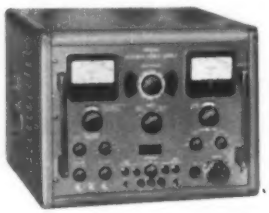
(COMBINED RATIO METER AND STANDING WAVE AMPLIFIER)

RATIO METER—1000 cps operation
VSWR Ranges: 1.02 to 1.22, 1.20 to ∞
Reflection Coefficient: .01 to .1, .1 to 1.0
Other Scales: db, Slotted Line VSWR
Standing Wave Amplifier—1000 cps operation
Range: 70 db in 10 db steps
Noise Level: .03 mv
Scales: VSWR, db, Expanded VSWR
Bolometer Bias: 4.5 and 8.75 ma
Input Impedance: 200 ohms or 200 K ohms



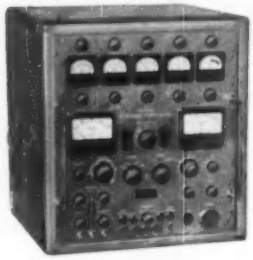
UNIVERSAL KLYSTRON POWER SUPPLY, 815

Beam: 200 to 2000 V, 125 ma max., 1800 to 3600 V, 100 ma or 250 W max.
Reflector: 0 to 1000 V
Control Grid: −300 to 0 to +150 V, 5 ma max.
Regulation: 0.03%
Ripple: 3 mv max.
Internal Reflector Modulation: Square Wave, Pulse, Sawtooth, Sine Wave



UNIVERSAL MICROWAVE POWER SUPPLY, 817

Helix or Beam: 0 to 1800 V, 125 ma max. 1700 to 3500 V, 100 ma or 250 W max.
Collector: 0 to 300 V, 100 ma max.
Anode: 0 to 600 V, 60 ma max.
G-1: 0 to 300 V, 5 ma max.
G-2 or Reflector: 0 to ±1200, 1 ma max.
G-3: 0 to ±750, 1 ma max.
G-4: 0 to ±500, 1 ma max.
Regulation: 0.03%. **Ripple:** 3 mv max.
Heater: 0 to 15 V D.C., Regulated.
Internal G-1 or G-2 Modulation: Sine Wave Square Wave, Pulse, Sawtooth



KLYSTRON POWER SUPPLY, 819

Beam: 300 to 1000 V, 85 ma max.
Reflector: 0 to 900 V, 20 μa max.
Control Grid: −300 to 0 to +150 V, 5 ma max.
Regulation: 1%
Ripple: 7 mv max.
Internal Reflector Modulation: Square Wave, Pulse, Sawtooth

FXR, Inc. formerly F-R MACHINE WORKS, Inc.

DESIGN • DEVELOPMENT • MANUFACTURE

PRECISION MICROWAVE EQUIPMENT
•
HIGH POWER MODULATORS
•
RADAR COMPONENTS
•
ELECTRONIC TEST EQUIPMENT

26-12 BOROUGH PLACE, WOODSIDE 77, N. Y.

TELEPHONE: AStoria 8-2800

your

two

best

friends...

"the man ahead"

and

"the man behind"

That man just ahead of you hopes you'll take his job away from him. He's plain selfish about it . . . that way you push him up the ladder, too.

The fellow right behind you, what about him? He's another good friend. Just help make him more capable of capturing your present spot . . . see, now he's pushing you!

How can you serve yourself better than you ever have before? By upgrading your own job performance. By learning all you can about other functions of your company's business. By putting today's problems together with tomorrow's promises . . . and becoming more and more knowing about both, right here in the high-utility pages of this one specialized publication.

This, don't ever forget, is your own magazine — for you and men like yourself to work things out together — to find new and better ways to make progress and profits. McGraw-Hill editors, who live on your street, unceasingly strive to make it the single greatest community of interest for your industry. And the more effort they put into it, the easier it is for you to get more out of it for every reading minute invested.

Look ahead, read ahead, get ahead. Live this secret. Share it. After you've read this issue so satisfyingly, hand it over to that man one step below. Show him how much there's in it for him, too. A few issues from now, we'll bet he looks you in the eye and says, "Thanks, friend. I just got my own subscription."

McGRAW-HILL SPECIALIZED PUBLICATIONS

The most interesting reading for the man most interested in moving ahead

the microwave range.

System now under construction was developed by the Signal R&D Labs at Fort Monmouth, N. J., from a concept that Bell Telephone Labs had toyed with earlier. It will be used for Army's strategic long-range communications networks. Chief advantage of the highly directional antenna is its lessened susceptibility to interference and jamming.

Requirements imposed by Army needs were high directivity and broad bandpass. DECo and Army spokesmen say the giant horn will have the beamwidth and bandwidth of an RD-4 rhombic—about 10-deg beam and overall useful range of from 5 to 25 mc—but without the rhombic sidelobes. Sidelobes are down 20 db or more from the mainbeam maximum.

The horn is 844 ft long, some 50 ft longer than the liner *Ile de France*. The waveguide feeding it is 40 ft wide and 80 ft high; the horn, fabricated as a curtain reflector, is twisted 45 deg and terminates in a rhombic mouth 506 ft wide and 253 ft high. Antenna, supporting structure and guy wires spread out over an area of 16.8 acres, with the antenna alone covering 6.9 acres. The size of the horn, Army spokesmen point out, is dictated by the need for high directivity.

The diamond-shaped aperture is truncated by the earth, mostly to ease problems of support and without materially affecting the horn's electrical characteristics.

E-field intensity at the mouth of the horn is at maximum in the center, tapers smoothly to zero at the corners. The antenna now abuilding at La Plata is a receiving antenna; additional engineering required to adapt it for transmitting is minor, say Army Signal engineers.

Antenna reflecting surfaces are wire-grid panels of No. 8 Copperweld wire. Specially designed wire-to-wire connectors are used for electrical and mechanical bonding at all intersections of lateral and longitudinal wires. The reflecting structure is supported by 18 steel towers of graduated height.

ELECTRONICS learned that the cost of the antenna system is upwards of $500,000, not counting the development and engineering costs. Checkout of the system as part of Army's strategic communications link will begin in the early Spring.

System Monitors Tv Programming

TRANSISTORIZED, automatic monitoring system for tv programs is being introduced this month to trade associations, advertising agencies and government bureaus.

The system takes 35-mm spot photos of the tv picture. At the same time it records the audio portion of the broadcast on magnetic tape and inserts the date and time in code. Normal recording speed is one picture every three seconds, but time span can be varied to permit taking a maximum of 10 pictures a second.

The unit is designed for use by monitor operators who need only unload the recorded information at intervals and mail it to New York headquarters for processing.

Actual recording of the photograph is done by a combination of electronic and optical equipment housed in a specially designed receiver. System designers, U. S. Broadcast Checking Corp., New York, will operate the checking devices on a service basis. They will be used to supply authenticated records of what commercials are being run in hard-to-check remote areas as well as urban regions. Firm now has studios and laboratories in New York, plans to establish a network of checking stations throughout the nation.

Automatic Feed

Tiny diode capsule parts are fed by vibrators to oxy-hydrogen rotary sealing machine in Sylvania plant

MEETINGS AHEAD

Dec. 3-5: Global Communications, AIEE, PGCS of IRE, Colonial Inn-Desert Ranch, St. Petersburg, Fla.

Dec. 3-5: Eastern Joint Computer Conf., AIEE, ACM, IRE, Bellevue-Stratford Hotel, Philadelphia.

Dec. 4-5: Vehicular Communications, Annual Meeting, PGVC of IRE, Hotel Sherman, Chicago.

Dec. 9-11: Mid-America Electronics Convention, MAECON, Municipal Auditorium, Kansas City, Mo.

Jan. 12-14: Reliability and Quality Control, Nat. Symp., PGEQC of IRE, ASQC, EIA, Bellevue-Stratford Hotel, Philadelphia.

Jan. 21-23: Southwest Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Ariz.

Jan. 29-30: Long-Distance Transmission by Waveguides, Institution of Electrical Engineers, London, England.

Feb. 1-6: American Institute of Electrical Engineers, Winter General Meeting, Statler Hotel, N.Y.C.

Feb. 12-13: Transistor & Solid-State Circuit Conf., AIEE, PGCT of IRE, Univ. of Penn., Philadelphia.

Feb. 12-13: Electronic Conference, AIEE, IRE, ISA, CPS, Eng. Soc. Bldg., Cleveland.

Mar. 3-5: Western Joint Computer Conf., AIEE, ACM, IRE, Fairmont Hotel, San Francisco.

Mar. 5-7: Western Space Age Conf. and Exhibit, L. A. Chamber of Commerce, Great Western Exhibit Center, Los Angeles.

Mar. 23-26: Institute of Radio Engineers, IRE National Convention, Coliseum & Waldorf-Astoria Hotel, New York City.

Mar. 26: Quality Control Clinic, ASQC, Univ. of Rochester, N. Y.

Mar. 31-Apr. 2: Millimeter Waves, Symposium, Polytechnic Inst. of Brooklyn, USAF, ONR, IRE, USA Signal Research, Engineering Societies Bldg., N.Y.C.

Apr. 5-10: Nuclear Congress, sponsored by over 25 major engineering and scientific societies, Public Auditorium, Cleveland.

Apr. 14-15: Industrial Instrumentation & Control Conf. PGIE of IRE, Armour Research Foundation, Illinois Inst. of Tech., Chicago.

CIRCLE 12 READERS SERVICE CARD→

Ampex Digital Tape Handlers

Compatible and a speed for each application

In back is the much talked of Ampex FR-300. Its 30,000- to 90,000-character-per-second transfer rates set a lively pace for the fastest digital computers. But these speeds must be brought back to earth for slower peripheral equipment. The Ampex FR-400 on the left is exactly the machine for this job. Tapes are transferable between the two (and also meet widely accepted industry standards).

The FR-400s can be likened to the entry and exit roads feeding traffic to a super-speed freeway. To put data into computer format, it serves in such conversions as analog-to-digital, punched-tape-to-magnetic-tape, and cards-to-tape. On the other end, the FR-400 feeds printers that get the answers back in writing. The FR-400 is also used for input/output for slower computers, but that's another story.

WORKHORSE QUALIFICATIONS

Carrying the freeway analogy a step further, imagine the traffic snarls that occur when exits are blocked. The Ampex FR-400 has a similar responsibility in the digital-data flow. It has been designed with tremendous stamina. It stays on the job.

For example, the FR-400's pinch-roller assembly passed a 15,000,000-cycle start-stop endurance test in our laboratory. Its design is the same as on the higher-speed FR-300. Also, the FR-400's torque motors are like those on the faster FR-300. And the heads are typical Ampex quality, made to take thousands of hours of wear without serious change.

A heavy-duty machine needn't demand heavy-duty people. The FR-400 has quick, easy in-line tape threading. Local controls are an available option, very convenient for tape change and equipment checkout. Then remote controls can take over — even from a source wired in from 1000 miles away.

COMPATIBILITY OF SPEEDS

In the matter of speeds, the FR-400 is like a power-line transformer that steps voltages down to the required levels of electrical equipment. Typical tapes made off computer by Ampex FR-300s involve transfer rate of 30,000 bits per second. Tape speed is 150 in/sec. Suppose a particular printer operates at 6000 characters per second. An FR-400 with 30 in/sec tape speed cuts transfer rate to ⅕th making the tape compatible with the printer's speed.

This can be carried still further — for example, to 5 in/sec tape speed and a 1000 character-per-second transfer. For still slower devices like paper-tape punches or card punches, a storage buffer is used. The magnetic-tape handler operates on a start-stop basis. A short burp fills the buffer. The card or paper-tape punch trails along after.

The FR-400 is available in a wide range of basic speed pairs. But Ampex also provides for sharing of tape handlers among conversion and readout devices of widely differing transfer rates. For this the FR-400 is available in 4-speed multirange versions, having two independent capstan motors. Thus the pairs of speeds may be very widely separated. 75, 37½, 10 and 5 inches per second is a typical example.

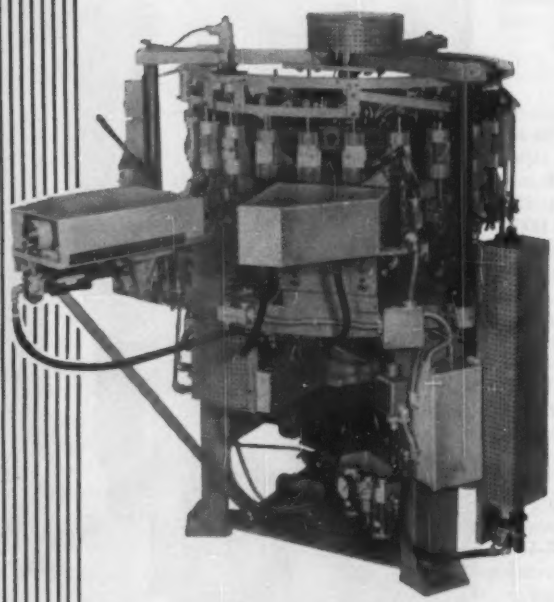
May we send specifications and descriptions on Ampex's various digital tape handlers or assist in some specific application? Write Department E-21.

AMPEX INSTRUMENTATION DIVISION • 860 CHARTER STREET • REDWOOD CITY, CALIFORNIA

Phone your Ampex data specialist for personal attention to your recording needs. Offices serve U. S. A. and Canada. Engineering representatives cover the free world.

THE BEST GLASS DIODES MADE....

ARE MADE ON KĀHLE MACHINES



Kahle automatic final seal machines . . . pre-tested under actual operating conditions prior to shipment . . . seal up to 1500 glass diodes per hour without an operator. Loading, unloading and pulse forming are all automatic. Designed to establish new standards of efficiency and economy in your operation, this machine is just one example of the full line of fine Kahle equipment for the production of semiconductors.

For detailed information, write to:

KĀHLE

ENGINEERING COMPANY

GENERAL OFFICES:
3314 Hudson Avenue, Union City, New Jersey

LEADING DESIGNERS AND BUILDERS OF MACHINERY FOR THE ELECTRONIC INDUSTRY

tubes cut costs of TV manufacture!

New 6AF3 and 12AF3 permit TV set-makers to profit more fully from economies of automated production.

Two new Tung-Sol damper diodes—6AF3 and 12AF3—bring TV manufacturers substantial dollar-savings through increased efficiency. Modern automatic assembly equipment is better able to process the miniature, button-stem dampers than prior octal-base types. Also, the new types allow standardization of tube and socket size—a big plus in printed circuit usage.

In addition to these cost-cutters, 6AF3 and 12AF3 offer premium performance. They approach the high ratings of the 6AU4GTA and 19AU4GTA . . . have the same heater power as the 6AX4GT and 12AX4GTA. Set-testing under actual overload conditions indicates the new tubes carry a greater "safety factor" than any previous damper.

The economy and top-flight quality of the 6AF3 and 12AF3 characterize the entire Tung-Sol tube line. For complete data on the new miniature dampers . . . to fill any entertainment socket, contact: *Tung-Sol Electric Inc., Newark 4, New Jersey.*

New Tung-Sol miniature dampers compared with types they replace

	BASING	LOAD-RATING	HEATER-RATING
6AF3 } 12AF3 }	Miniature	185ma*	6.3v, 1.2a / 12.6v, 0.6a
6AX4GT } 12AX4GTA }	Octal	125ma†	6.3v, 1.2a / 12.6v, 0.6a
6AU4GTA } 19AU4GTA }	Octal	190ma†	6.3v, 1.8a / 18.9v, 0.6a
12D4	Octal	145ma†	12.6v, 0.6a

*According to Design Maximum System of Ratings
†According to Design Center System of Ratings

TUNG-SOL®

CIRCLE 14 READERS SERVICE CARD

Read directly

1μμa

and

1μv

with 10 times previous accuracy!

Drift less than ± 2 μv; noise less than 0.2 μv!

New -*hp*- 425A Microvolt-Ammeter

now makes these difficult measurements quickly and easily!

ENGINEERING

Minute dc potentials, difference voltages, nulls

Resistances from milliohms to 10 megmegohms*

Use with Esterline-Angus, other recorders

PHYSICS, CHEMISTRY

Grid, photomultiplier currents

Ionization levels in vacuum

Thermocouple potentials

Voltaic currents in chemicals

MEDICINE, BIOLOGY

Voltages in living cells

Nerve voltages

Voltages in plants, seeds

*with external dc source.

hp is announcing more than 30

The all-new *-hp-* 425A Microvolt-Ammeter will provide engineers, physicists, chemists and physiological scientists with one compact, direct-reading instrument measuring minute voltages and currents with speed, simplicity and 10 times the sensitivity of the complex equipment arrays previously required.

Very careful engineering, including heavy filtering against ac signals and substitution of a unique photoelectric chopper for the conventional mechanical vibrator, has resulted in performance heretofore unobtainable. The long-term drift of the 425A is less than 2μv and internal noise is less than 0.2 μv.

Conservative electrically, Model 425A includes every conceivable assurance of safety, accuracy and dependability. For example, momentary overloads of 1,000 volts cause no damage; and the new pickup probe is specially designed to minimize thermocouple and triboelectric effects. The meter provides constant polarity indication.

The new *-hp-* 425A also may be used to measure a wide range of resistances. Milliohms may be measured by using a battery and series resistor as a constant current source. Higher resistances may be measured with higher voltages; a 100 volt supply allows the 425A to measure accurately up to 10 megmegohms.

Call your *-hp-* representative now for demonstration on your bench; or, write for details.

HEWLETT-PACKARD COMPANY
4882A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
Cable "HEWPACK" • DAvenport 5-4451
FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

SPECIFICATIONS

MICROVOLT-AMMETER

Voltage Range:	Positive and negative voltages from 10 μv full scale to 1 v full scale in an eleven step, 1, 3, 10 sequence.
Current Range:	Positive and negative currents from 10 $\mu\mu$a full scale to 3 ma full scale in an eighteen step, 1-3-10 sequence.
Input Impedance:	Voltage Ranges: 1 megohm ±5%. Current Ranges: Depends on range, 1 megohm to 0.33 ohm.
Accuracy:	Within ±3% of full scale.

AMPLIFIER

Frequency Range:	dc to 0.2 cps.
Gain:	100,000 maximum.
Output:	0 to 1 v for full scale reading, adjustable.
Output Impedance:	10 ohms, shunted by 1000 ohm potentiometer.
Noise:	Less than 0.2 μv rms referred to input.
Drift:	After 15 minute warm-up, less than ±2 μv per hour referred to the input.
Power:	115 v ±10 v, 230 ±20 v, 60 cps, 40 watts.
Dimensions:	Cabinet Mount: 7½" wide, 11¼" high, 14" deep.
Weight:	Net 20 lbs.
Price:	$500.00. *-hp-* 425AR (rack mount) $505.00. *-hp-* 425A (cabinet) $500.00.

Data subject to change without notice. Prices f.o.b. factory.

basic new instruments in 1958

Transitron announces

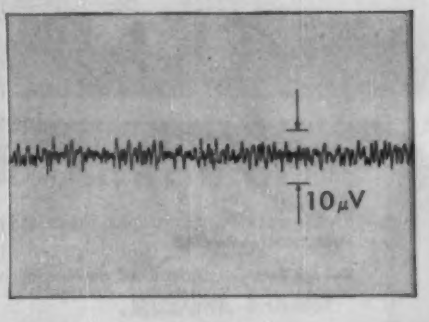
5 NEW TYPES OF SILICON TRANSISTORS

LOW NOISE type... *lowest noise figure yet achieved*

in the critical range from one cycle per second to audio frequencies. The ST1050 offers improved equipment stability down to a fraction of a cycle per second. Use it for all low level amplification problems having an input source impedance of 50 Kohms or less . . . strain gages, thermocouples, accelerometers.

TYPE	ST1050	
Equivalent Input Noise Voltage (0.8 to 50 cps)	2.5	μV RMS
DC Beta @ I_c = 20μa	20	—
Collector Cutoff Current (25°C, −3V)	.002	μa
Collector Cutoff Current (100°C, −3V)	0.2	μa

Complete data in bulletin TE-1353

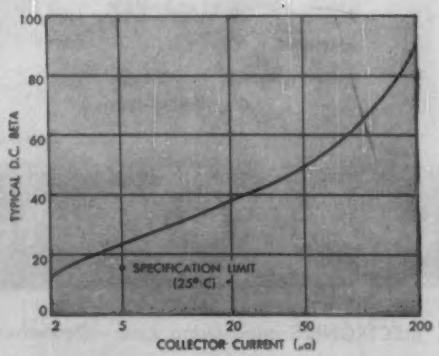


LOW LEVEL INPUT type... *extremely low drift*

over the recommended operating range of 2-200 μa collector current. With typical drift of only 1.0 milli-microamps per degree C and 5 milli-microamps per day, ST1026 may be used in circuits with high impedance sources . . . phototubes, G-M tubes, infra red tubes and ionization gages. Many new low current applications are opened up by the high beta and extremely low I_{co}.

TYPE	ST1026	
Minimum DC Beta @ 5 μa	15	—
Maximum Collector Cutoff Current (25°C, −3V)	.005	μa
Typical Collector Cutoff Current (100°C, −3V)	0.2	μa

Complete data in bulletin TE-1353



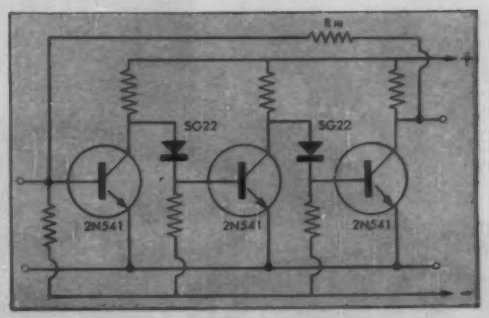
CIRCLE 17 READERS SERVICE CARD

HIGH BETA types... *current gain of 80 minimum,*

the highest level yet achieved in the industry. A useful end-of-life beta is maintained at temperatures down to −65°C, even at reduced collector current levels. The high gain of these transistors reduces the number of stages required in amplifier applications. A greater degree of degenerative feedback may be used to obtain much greater gain stability and uniformity, resulting in *reliable* amplifier operation.

TYPES	2N543	2N542	2N541	
Minimum Common Emitter Current Gain @ 1 Kc	80	80	80	—
Typical Common Emitter Current Gain @ 1 Mc	15	15	15	—
Maximum Collector Voltage	45	30	15	Volts
Maximum Collector Cutoff Current (25°C @ V_C Max.)	.5	.5	.5	μa

Complete data in bulletin TE-1393



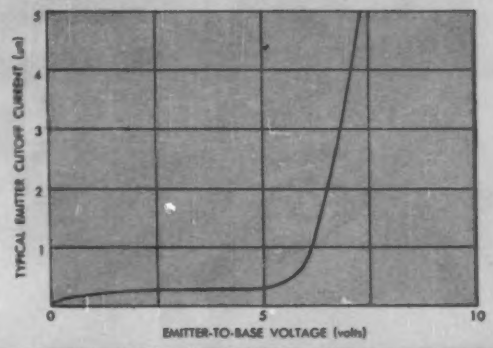
HIGH V_{EB}/SMALL SIGNAL types

... V_{EB} of 5 Volts minimum

eliminates the need for series diodes in many applications and protects against transients in pulse and digital circuitry. This improvement in emitter-to-base voltage is available in Transitron's entire line of small signal transistors, at no sacrifice of other characteristics.

TYPES	2N543A	2N480A	2N475A	
Maximum Emitter-to-Base Voltage	5	5	5	Volts
Maximum Collector Voltage	45	45	45	Volts
Minimum Common Emitter Current Gain	80	40	20	—
Maximum Collector Cutoff Current (@ V_C = 45 Volts)	.5	.5	.5	μa

Complete data in bulletin TE-1353



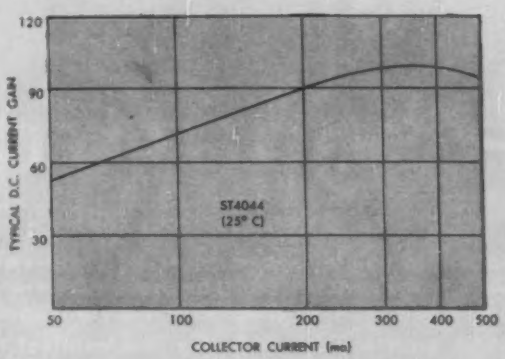
HIGH BETA/MEDIUM POWER types

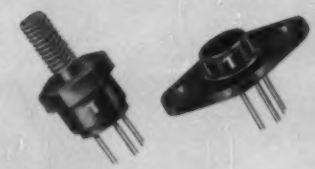
... current gain of 40 minimum

at 500 milliamps. Typical power gain of 1000 into a 100 ohm load significantly reduces drive power requirements. When used in conjunction with small signal high gain types, these transistors reduce the number of components needed in a system and, hence, the overall weight and volume. I_{CO} is measured at maximum rated collector voltage at 150°C.

TYPES	ST4044	ST4045	
Minimum DC Beta = 40 at I_C	500	200	ma
Maximum Collector Voltage	60	60	Volts
Power Dissipation (100°C, free air)	0	.6	Watt
Power Dissipation (100°C, stud heat sink mounting)	5	5	Watts
Typical Collector Saturation Voltage (@ specified current)	3	1.5	Volts

Complete data in bulletin TE-1355





HEAT SINK MOUNTINGS... *higher power ratings*

for medium power transistors in Transitron's TO-5 Outline package. These factory-fitted heat sink mountings make possible a realistic 5 watt rating at 100°C case temperature for the first time. The stud type offers the convenience of single-hole mounting, the same as for our JAN rectifiers in the 7/16" hex package. No clip is needed ... insulation and mounting hardware are supplied. Complete data in bulletin TE-1355.

Transitron

electronic corporation • wakefield, massachusetts

Transistors Diodes Regulators Rectifiers

CIRCLE 18 READERS SERVICE CARD

Designed for the most exacting applications of storage and display

Federal IATRONS*

Iatron storage tubes give you a broad range of characteristics around which to design advanced systems for writing, storing, displaying, and erasing information.

In all-weather radar, Iatrons have a high order of halftone resolution that facilitates distinguishing of cloud formations.

In ground radar, Iatrons permit accurate, convenient daylight viewing because of their high brightness—up to 10,000 foot-lamberts—ample for projection systems.

In scan conversion systems, observation of single transients, sequential display of instrument data and similar uses, Iatrons offer resolution up to 80 lines/inch and high writing speeds.

Developed by men who have led in storage device technology, Iatrons are manufactured to the high standards of reliability which have made Federal tubes famous for over half a century. Write today for complete data.

TYPE	DIAMETER	FOCUS	DEFLECTION	WRITING SPEED IN./SEC.	ERASING TIME	VIEWING TIME (MAX.)	RESOLUTION LINES/IN.	BRIGHTNESS FT.-LAMBERTS
7173	4" direct view	electromagnetic	electromagnetic	200,000	3 millisec.	30 sec.	50	2800
7174	4" projection	electromagnetic	electromagnetic	200,000	3 millisec.	30 sec.	50	10,000
7175	5" direct view	electrostatic	electromagnetic	250,000	3 millisec.	40 sec.	80	2500
7176	5" direct view	electrostatic	electrostatic	250,000	3 millisec.	40 sec.	80	2500

ITT

Box F0010, *Vacuum Tube Department, Components Division*
INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
Box 412, Clifton, New Jersey

*Trademark of International Telephone & Telegraph Corporation.

CIRCLE 19 READERS SERVICE CARD

CIRCLE 20 READERS SERVICE CARD→

Simply slide together
and lock with thumbscrew on back.

New Triplett Unimeters

Decrease Inventory Cost . . . Increase Flexibility

With the New Select-Your-Range Triplett Unimeters two basic meter movements can be combined with any number of Dial-Component units for a wide variety of panel meter ranges—you can even create your own ranges with available dial blanks by following simple instructions furnished.

Since the basic movement accounts for the greater part of the meter cost—you can have a much more flexible inventory by stocking the minimum number of basic meter movements and a large variety and maximum quantity of the inexpensive Dial-Components.

Unimeter features are: self-shielded Bar-Ring movements: AC and DC linear scales • extreme accuracy • dustproof construction • error proof assembly • instant conversion • standard mounting.

For complete details see your Electronic Parts Distributor, or write

TRIPLETT ELECTRICAL INSTRUMENT COMPANY
BLUFFTON, OHIO

Three Standard Kits, too. Kit A (makes 8 ranges), Kit B (makes 12 ranges), Kit C (makes 23 ranges).

PRD

PACEMAKER LINE

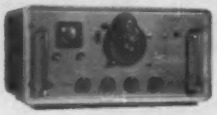
BROADBAND

Direct Reading Frequency Meters

MOST COMPLETE LINE...
FOR EVERY PURPOSE, EVERY BUDGET

HIGH PRECISION, DIRECT READING METERS (0.015%)
Series 555 to 579 consists of 30 different types covering from 0.925 to 39.0 KMC/S. Representing highest state of the art, these frequency meters fully qualify as transfer or secondary standards for exacting laboratory or production service. Features include: hermetically sealed invar cavity, temperature-compensation, high Q, optimum cavity geometry, high conductivity plating.

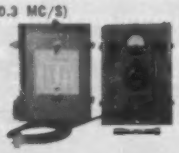
RECISION HETERODYNE FREQUENCY METER (0.002%)
Type 504, for 100 to 10,000 MC/S with accuracy of 0.002% at crystal check points every 5 MC/S and 0.03% or better between check points. Automatic interpolation by unique patented spiral-scale dial. Beat indication by both external earphones and built-in CRT. Meter is self-contained and portable.



INEXPENSIVE, DIRECT READING METERS (0.08%)
Series 585-A to 590-A affords excellent accuracy at lowest cost from 5.1 to 10.0 KMC/S. Ideally suited for panel mounting.

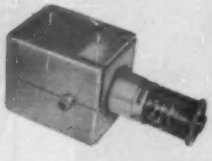
COAXIAL FREQUENCY METERS:

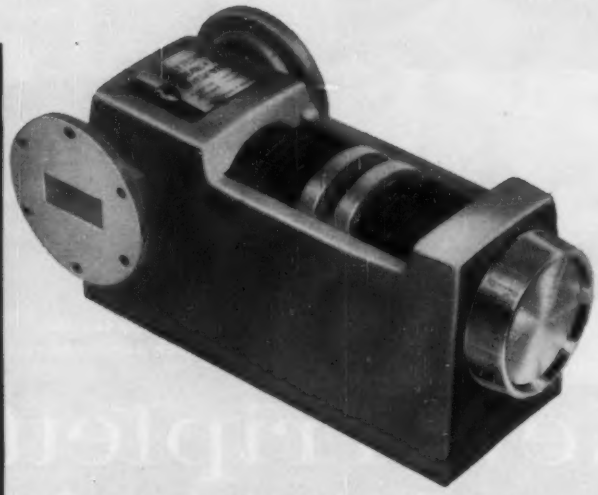
LINE TERMINATING, HIGH PRECISION METER (±0.3 MC/S)
Type 560, ranges 2.4 to 3.4 and 2.7 to 3.7 KMC/S. Extremely wide range of pulse average power as well as CW can be handled. Hermetically sealed cavity and temperature-compensation permit operation under conditions of adverse humidity or large temperature variations.



CALIBRATED, PRECISION METER (±0.3 MC/S)
Type 583-D, for 2.4 to 3.7 KMC/S. Temperature-compensation and hermetical sealing insure optimum performance under all atmospheric conditions.

DIRECT READING UHF METER (±0.2%)
Type 587-A, covers range 250 to 1000 MC/S. Spiral drum scale 60 inches long enables precision direct reading. May also be used as a tunable narrow band filter.





Seven full waveguide bandwidths are each covered by a separate meter in this 532 series of nine reaction-coupled frequency meters, extending over the complete range from 3.95 to 40.0 KMC/S.

These frequency meters consist of a TE_{111} mode cavity resonator tuned by a non-contacting plunger. Ruggedness for long trouble-free life is assured by all-metal construction. Maximum readability, resolution and accuracy to ±0.08% are the result of an optimized design distinguished by a drum type spiral scale more than 8 feet long.

Full details of PRD FREQUENCY METERS *and the complete PRD* PACEMAKER LINE *are contained in this new 160 page PRD Microwave Catalog, largest and most informative ever published. It is available without cost or obligation to those engaged in microwave work. Write for your copy today.*

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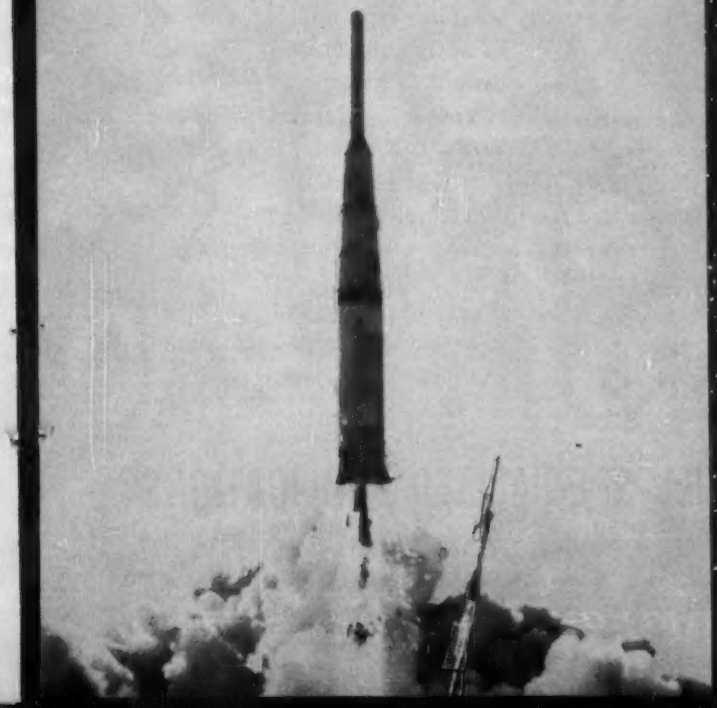
Pioneer, setting new apogees in science and missilery, typifies the achievements STL is making in the advancement of space technology. Those who are able to contribute to and benefit from these developments are invited to consider joining our staff.

Space Technology Laboratories



Space Technology Laboratories, Inc.
5730 Arbor Vitae Street, Los Angeles 45, California

"George is great . . . right where he is!"

If ever a compliment could cut the ground out from under a man — you just read it. Just make sure your management never says it about you.

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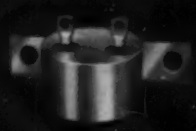
nsulated, electrically in-dependent bimetal disc ives fast response and uick, snap-action control. peration from -10° to 00°F or higher on special rders. Various mountings nd terminals. Average ating 6½ amps at 115 olts AC, 4 amps at 230 olts AC and 28 volts DC. ee Bulletin 3000.



TYPE A*
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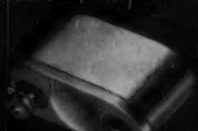
Electrically identical to semi-enclosed Type A. Temperatures from -10° to 300°F. Various enclosures and mountings, including brackets, available. For appliance, electronic apparatus applications. Bulletin 3000.



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Simplified Test Saves Engineering Man Hours

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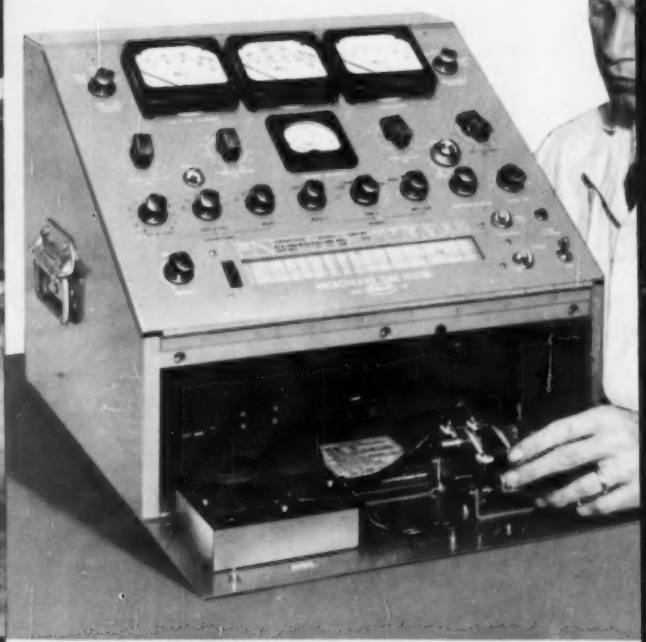
Model K-200



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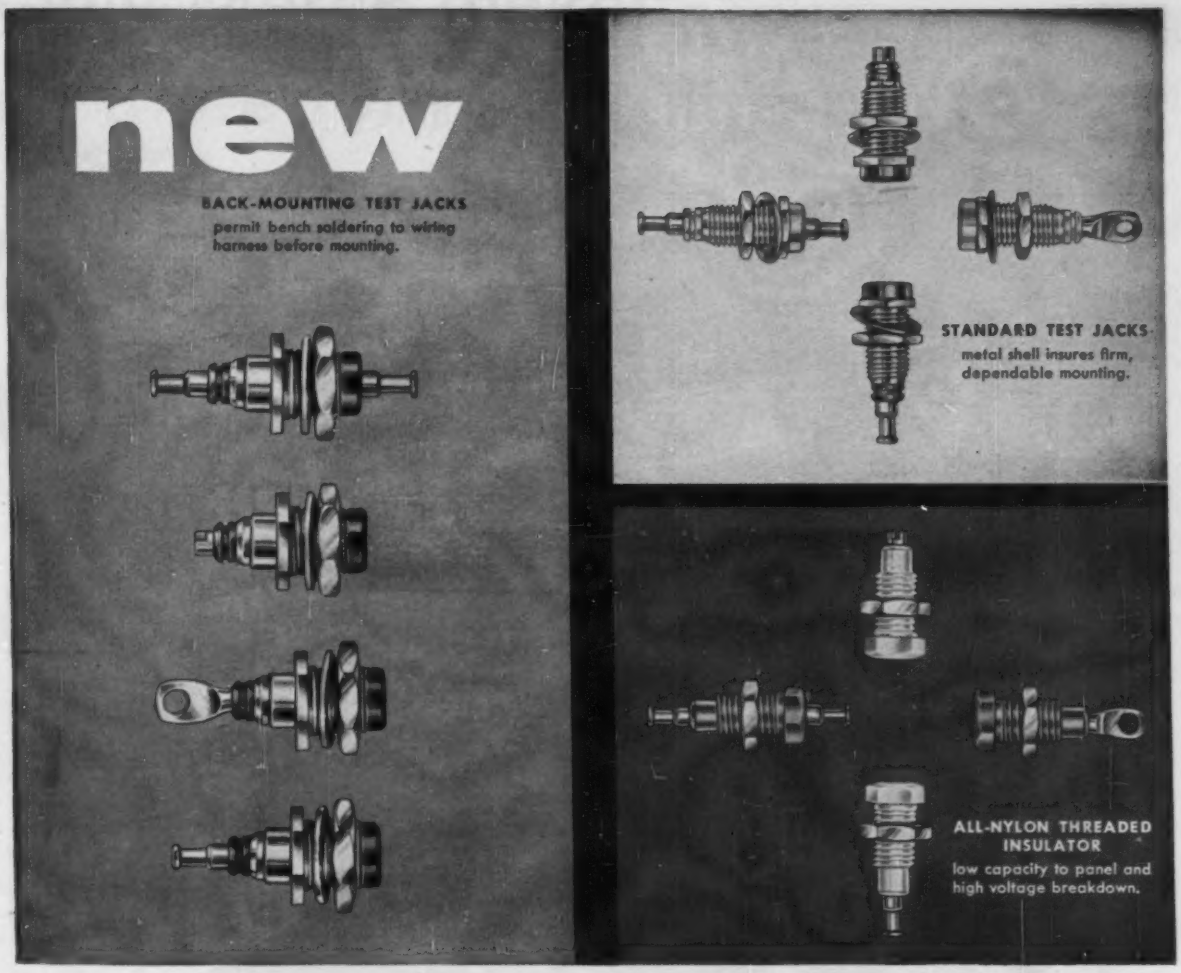
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metal shell insures firm, dependable mounting.
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low capacity to panel and high voltage breakdown.

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for semiconductor applications

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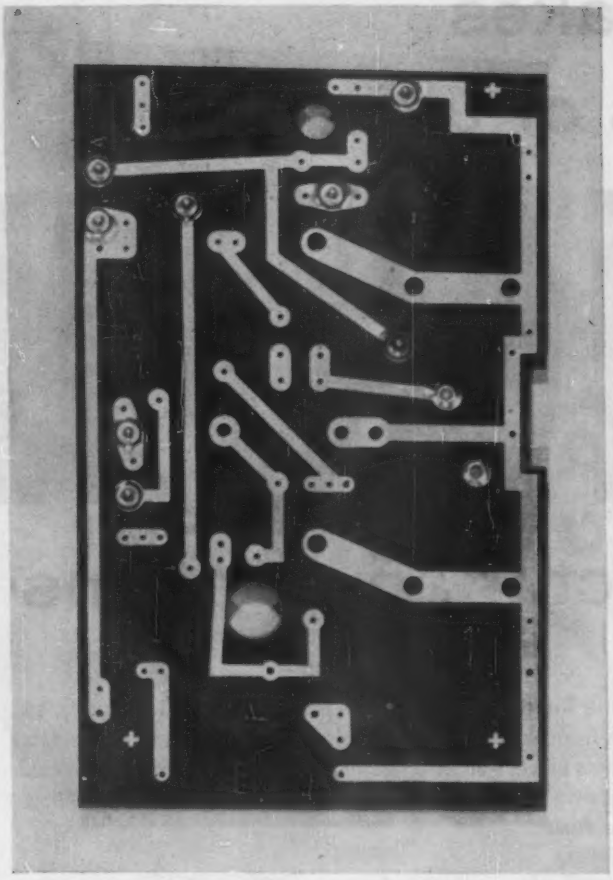
BASE BORON CONTENT BELOW ONE ATOM OF BORON PER SIX BILLION SILICON ATOMS



How CDF Di-Clad† can solve your printed-circuit problems

The CDF line of copper-clad laminates in all grades is now known by a new name—Di-Clad. Di-Clad grades meet the varying needs of design, production, and operation of electronic equipment. Grades other than those described are also available.

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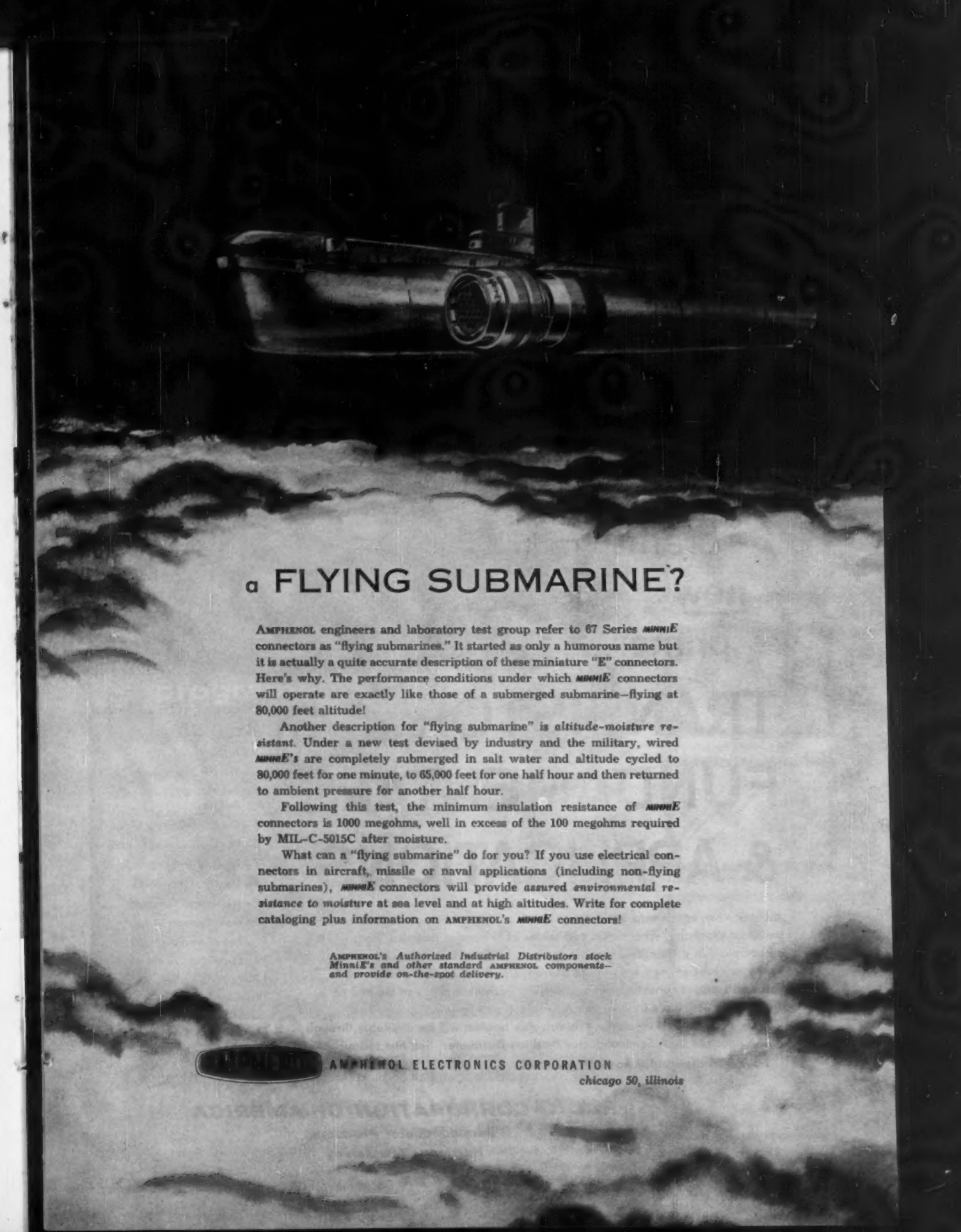
	Di-Clad 2350	Di-Clad 26 (NEMA XXXP)	Di-Clad 28 (NEMA XXXP)	Di-Clad 28E (NEMA G-10)	Di-Clad 112T Teflon*
BOND STRENGTH—0.0014" foil (lbs. reqd. to separate 1" width of foil from laminate)	6 to 10	6 to 10	6 to 10	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMPERATURE (Deg. C.)	120	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil for 1/16" thickness)	800	900	850	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90% RH (ASTM D257, Fig. 3)	500	150,000	600,000	100,000	75,000
DIELECTRIC CONSTANT 10^6 Cycles	4.5	4.0	3.6	4.9	2.6
DISSIPATION FACTOR 10^6 Cycles	0.040	0.026	0.027	0.019	0.0015
ARC-RESISTANCE (Seconds)	5	10	10	130	180
TENSILE STRENGTH (psi.)	18,000	16,000	12,000	48,000	23,000
FLEXURAL STRENGTH (psi.)	27,000	21,000	18,000	70,000	13,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.80	0.45	0.42	12.0	6.0
COMPRESSIVE STRENGTH flatwise (psi.)	32,000	28,000	25,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Paper	Paper	Paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural	Natural greenish	Natural	Natural	Natural

All these standard grades are available with 0.0014" and 0.0028" or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*Du Pont Trademark



a FLYING SUBMARINE?

AMPHENOL engineers and laboratory test group refer to 67 Series *MINNIE* connectors as "flying submarines." It started as only a humorous name but it is actually a quite accurate description of these miniature "E" connectors. Here's why. The performance conditions under which *MINNIE* connectors will operate are exactly like those of a submerged submarine—flying at 80,000 feet altitude!

Another description for "flying submarine" is *altitude-moisture resistant*. Under a new test devised by industry and the military, wired *MINNIE's* are completely submerged in salt water and altitude cycled to 80,000 feet for one minute, to 65,000 feet for one half hour and then returned to ambient pressure for another half hour.

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What can a "flying submarine" do for you? If you use electrical connectors in aircraft, missile or naval applications (including non-flying submarines), *MINNIE* connectors will provide *assured environmental resistance to moisture* at sea level and at high altitudes. Write for complete cataloging plus information on AMPHENOL's *MINNIE* connectors!

AMPHENOL's Authorized Industrial Distributors stock MinniE's and other standard AMPHENOL components—and provide on-the-spot delivery.

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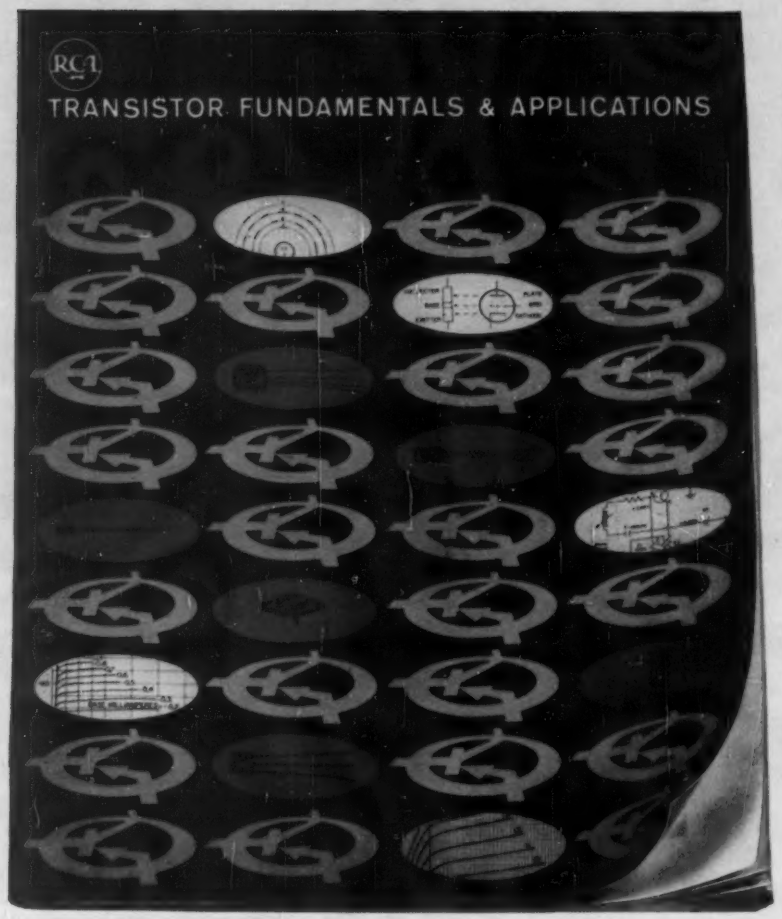
Now Available!



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8—*Transistor Amplifiers*
9—*Methods of Coupling*
10—*Gain Controls*
11—*Power Amplifiers*
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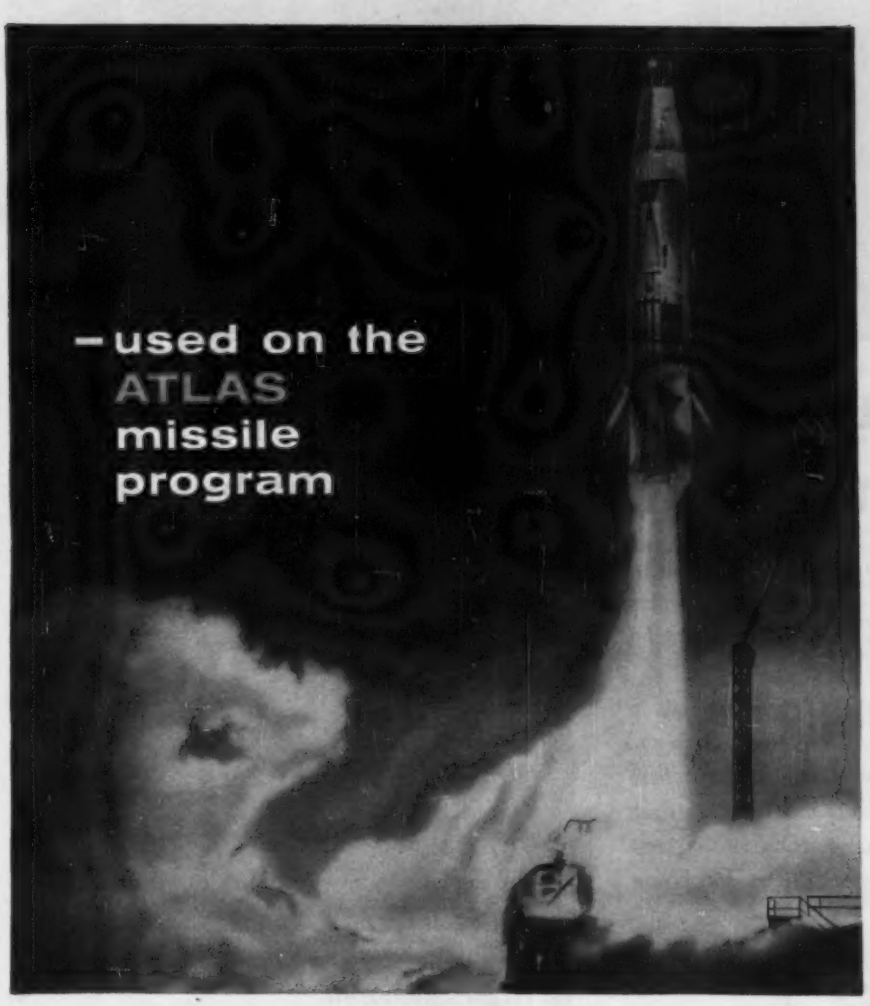
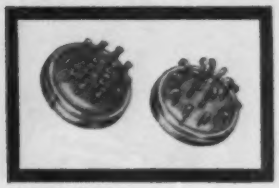
GLASS-TO-METAL SEALS by E-I



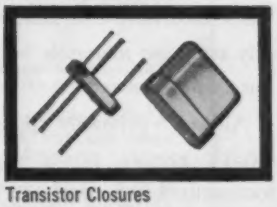
Plug-in Connectors

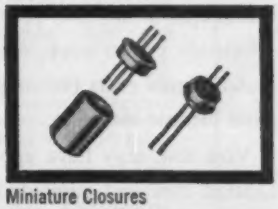
Single Lead Terminals

End Seals for Tubular Components


Multiple Headers

Threaded End Seals


Transistor Closures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Color Coded Terminals

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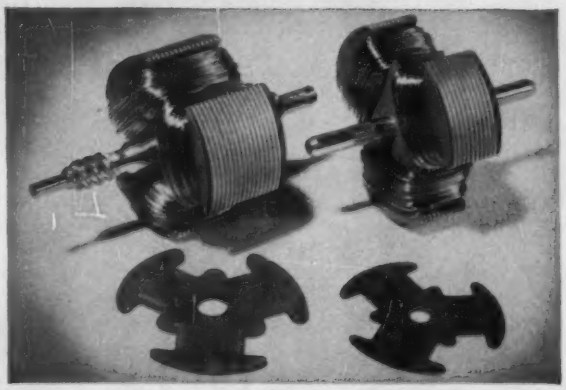
Taylor insulating materials help keep Lionel trains rolling, too

Model trains and the giant real things use hundreds of vulcanized fibre and laminated plastic parts. Designers rely on these materials because of high reliability and low cost.

Although primarily applied as insulating materials in electric motors, power supply units, track elements, locomotives and cars—there are many instances where the unique mechanical properties of these materials are effectively put to work. An example is the use of laminated plastic gears (silent gear stock) to transfer power from electric motors.

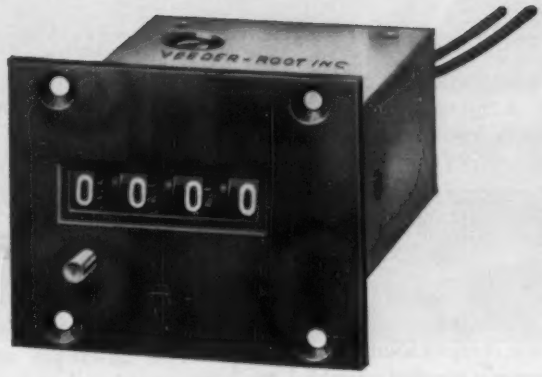
You, too, may have applications where Taylor vulcanized fibre and laminated plastics will cut costs and improve product reliability. Our application engineers will be glad to discuss them with you. Both our plants—Norristown, Pa., and La Verne, Calif.—are equipped for prompt supply of basic materials or fabricated parts. Write us for details. TAYLOR FIBRE CO., Norristown 40, Pa.



Taylor Vulcanized Fibre Parts Insulate the rotors used to power Lionel model engines. Photos supplied by courtesy of The Lionel Corporation.

Taylor

LAMINATED PLASTICS / VULCANIZED FIBRE



You told us to "tell all" about this ALL-NEW PANEL-MOUNTED HIGH SPEED ELECTRICAL COUNTER

You asked for it! Hundreds of requests for "complete specs" rolled in on the announcement of the 1591. So here they are . . . all on one sheet . . . for your counter file. And here's a quick review of the most newsworthy features of this all-new counter:

- Instant electric resetting.
- Push-button reset, either mechanically on the machine, or electrically from a distance.
- One button resets an entire panel.
- Panels can go right in your office.
- Counter is small, but figures are large.
- Speeds rated to 3,000 counts per minute.

ORDER NOW!

EVERYONE CAN COUNT ON

Veeder-Root

INCORPORATED

Hartford 2, Connecticut

Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities

For Your COUNTROL FILE

Complete Specifications ...Series 1591 Counter

•

Overall Dimensions: 2.1" wide, 1.7" high, 2.6" deep. Shipping weight approximately 1 lb.

Method of Counting: Actuated through electromagnets, these counters can be connected in series with any device having a contact arrangement. For optimum operation, 60% contact time is necessary.

Reset: Manual or electrical. Manual reset is accomplished by depressing the reset button extending through the front panel. Electrical reset is accomplished by energizing the resetting coil momentarily.

Size of Figures: .188" high.

Color of Figures: White on black.

Number of Figures: 4 or 6.

Speed: 3000 counts per minute is the maximum recommended.

Watt Consumption: Operating coil — 6 watts, reset coil — 15 watts.

Operating Voltage: 6, 12, 24, 48 & 115 volts DC are standard. For operation on AC power, suitable electrical components must be added externally to the counter.

Reset Voltage: 6, 12, 24, 48 & 115 volts DC are standard.

Voltage Variation Permissible: 10%, but not more than 10 volts.

Temperature Rise: 140°F under normal operating conditions when coils are left energized for long periods of time.

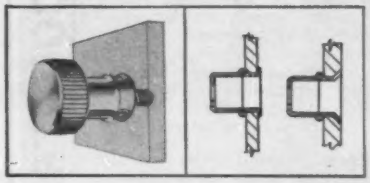
Lubrication: After every 30-million counts, lubricate per Veeder-Root service instructions V-78116-1.

Finish: Die-cast frame, with aluminum covers. Panel Plate dull instrument black.

NOTE: Any change in any of these Standard Specifications (above) makes the counter a Non-Standard item, produced to order only.

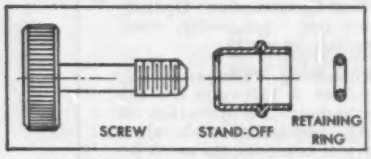
SELECT CLOSURE HARDWARE TO IMPROVE UTILITY, APPEARANCE, AND TO LOWER COST

QUICKLY INSTALLED SOUTHCO CAPTIVE PANEL SCREWS END MISALIGNMENT PROBLEM . . .



Simplicity of design contributes to clean, distinctive appearance and fast, low-cost installation. Stand-off is slipped into panel hole and secured by flaring. Screw is passed through stand-off and made captive by vinyl o-ring.

"Floating" screw design eliminates costly close tolerance manufacture and permits easy engagement regardless of panel distortion encountered under adverse use conditions.



SPECIFICATIONS

Material: Screw is brass, chrome plated; can be supplied in stainless steel. O-ring is vinyl plastic.
Overall length of screw: 1 3/16"
Depth of screw head: ¼"

Sizes:

SCREW HEAD DIAMETER	THREAD SIZE
¾"	¼-20
9/16"	¼-20, 12-24
7/16"	10-24,10-32

Length of thread: ⅜"

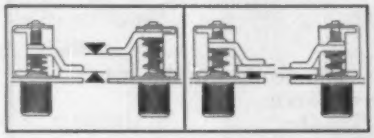
Screw head is supplied plain, as shown, or slotted for screw driver.

PRE-ASSEMBLED PAWL ADJUSTS TO DESIRED THICKNESS AND PRESSURE

This neat, compact Southco panel and door fastener is supplied assembled, requires but two rivets or bolts for low cost installation. It is available in three models—large, intermediate and midget.

The unique feature of Southco Pawl Fasteners is the fact that, by merely turning the knob, the pawl is adjusted to a wide range of frame thicknesses. This assures a tight grip without precision setting regardless of variations in frame or door dimensions or changes that are produced by wear or warping of sheets.

Pressure exerted by the pawl on the frame is controlled in the same way, by merely turning the knob. Against gasketed frames, pressure can be easily applied to compress the gasket.



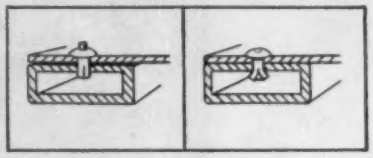
SPECIFICATIONS

Knob: Cadmium or chromium plated steel.

Head Styles: Protruding ribbed or knurled knob; flush screw driver slotted for large size only.

	LARGE	INTERMEDIATE	MIDGET
Knob diameter	⅞"	9/16"	11/32"
Total width	2½"	1¾"	1⅛"
Total height	1 5/16"	⅞"	25/64"
Back of panel depth	1 23/32"	1¼"	⅞"
Knob length	1⅛"	13/16"	9/32"

FAST, HAMMER-DRIVEN BLIND RIVETS CUT INSTALLATION TIME



You "hit-the-pin" and the rivet's in. No special tools to limit production or require maintenance, no bucking, no finishing. For blind or open applications, Southco Drive Rivets save time, reduce costs.

Automatic "pull-up" action assures uniform, tight grip.

Southco Rivets are made of aluminum or cadmium plated steel with cadmium plated or stainless steel pins. Diameters are from 1/8" to ¼", grip range is from 1/16" to ⅜".

Increased widespread use is due to low installed cost and elimination of down time and maintenance associated with fasteners requiring special tools.

FREE!

Fastener Handbook

Send for your free copy of Handbook No. 8, just released. Gives complete data for designers on these and many other specialty fasteners. 48 pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.

SOUTHCO FASTENERS
LION

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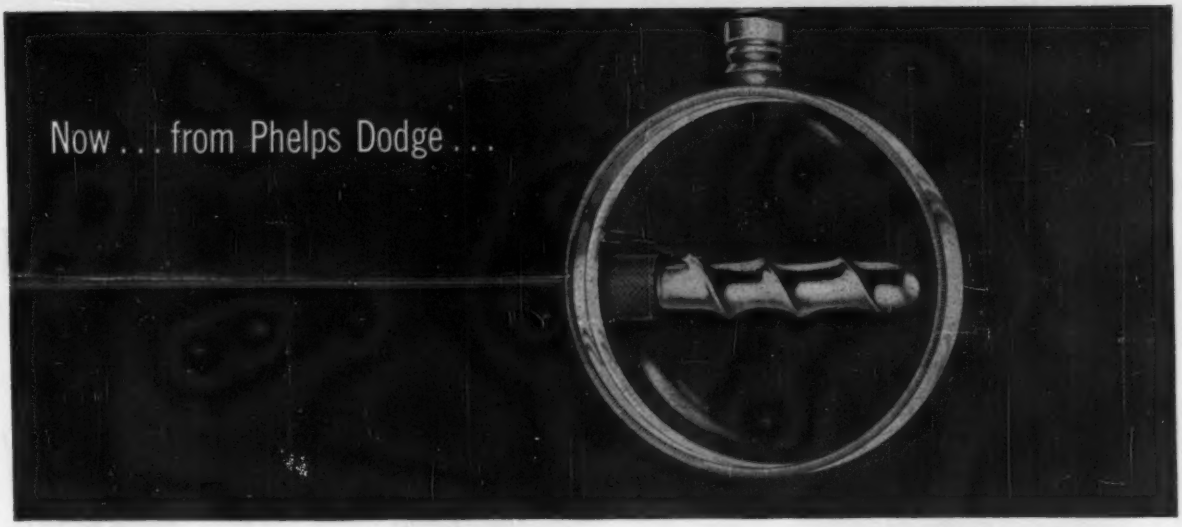


First complete line of Solderable Magnet Wires for the Electronics Industry!

S-Y BONDEZE® — answers the long-awaited need for a self-bonding wire that is solderable at low temperatures. The high temperature cut-thru resistance of the underlying film will reduce the number of shorts in your coils.

NYLEZE® — a tough, all-purpose, solderable wire for your most severe applications. Especially suited for use in high speed automatic winding equipment or wherever extreme varnish or compound treatment is involved.

SODEREZE® — the magnet wire that is solderable at low temperature, proven over the years in thousands of customer applications.

GRIP-EZE® — a solderable film wire with controlled surface friction for use in lattice-wound coils. A special surface treatment provides mechanical gripping between turns and keeps the wire in place.

All Phelps Dodge *solderable* magnet wires are red in color.

Any time your problem is magnet wire, consult Phelps Dodge for the quickest, easiest answer!

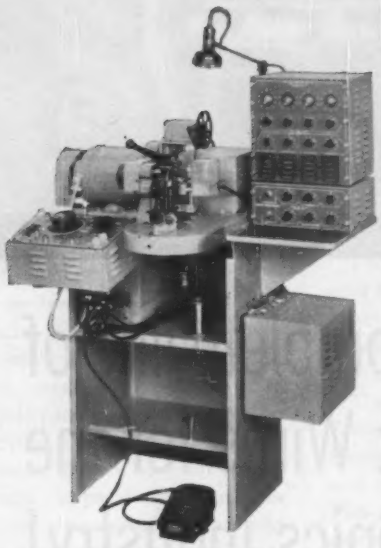
FIRST FOR LASTING QUALITY —FROM MINE TO MARKET!

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

BOESCH WINDING MACHINES



MODEL 300 TOROIDAL WINDER . . .

. . . A significant step toward automation

For toroidal coil sizes 0.218" ID to 5" OD, wire sizes #20 through #42 AWG, Boesch offers four machines . . . the new TW300 and TW251 and the well-known TW200 and TW201. Shuttle heads and shuttles are interchangeable on all machines.

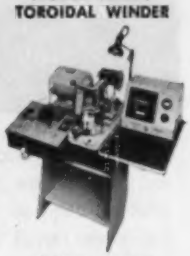
Electronic controls of the TW300 provide features never before offered in a toroidal winder . . . 100% accuracy in counting turns of any size wire without physical contact . . . speeds up to 2000 turns per minute . . . 4-digit, 2 or 7 position predetermined turns counting . . . controlled acceleration and deceleration . . . automatic winding of any segment configuration with exact repeatability . . . progressive winding of segments or continuous coils in either direction. A significant step toward automation of toroidal winding, the TW300 cuts production time and operator fatigue, and offers unlimited flexibility in the production of new coil types with superior electrical characteristics.

A work horse of the industry, the TW200 is also a fully automatic high-production machine . . . wire spacing is variable, core rotates automatically for continuous winding, or oscillates through any angle between 45° and 180° for segmental winding. Available with predetermined mechanical footage counter for loading shuttle, with optional fixed or 0-1200 rpm variable speed, and choice of 6-digit single-setting, or 5-digit 5-setting electronic predetermined-turns counters.

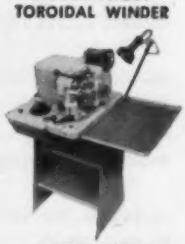
The TW201 is an economical production winder . . . a professional aid in the laboratory, a dependable winder in production. Core is oscillated manually by a single lever, but clamped mechanically. Winds standard coils without attachments. Available with same choice of counters and drives as the TW200.

The new low-cost TW251 is a packaged unit, complete and ready for operation. Similar to TW201 but has built-in non-predetermined turns counter and AC drive variable up to 1000 rpm. A slower-winding laboratory machine, but usable in production like TW201 by addition of predetermined turns counter. Uses same special-purpose accessories as TW200 and TW201.

MODEL TW200 TOROIDAL WINDER



MODEL TW201 TOROIDAL WINDER



MODEL TW251 TOROIDAL WINDER

MODEL TW
TAPE WINDER

A motor-driven winder for applying non-adhesive tapes to toroidal cores and coils. Its quick operation makes it a highly valuable production tool, one minute's time to tape a core or coil is typical. Speed is variable, handles coil sizes from ¼" ID to 4" OD, winds mylar, rayon, cotton, silk or glass tapes in widths ⅛", 3/16", ¼", ⅜", and ½". Tape overlap is continuously adjustable.

MODEL BW2
BOBBIN WINDER

A quick, rugged, versatile, completely automatic winder for bobbins, solenoids, resistors, relays and other random-wound coils. Speed is variable to 8000 RPM, winds coils from 1/32 to 5 inches in length, diameters to 5 inches, wire sizes #17 through #50 AWG. Features single and multiple winding, automatic acceleration control, finger-tip controls, operator safety provisions, life-time lubrication, plug-in electrical components. Only 8 by 34 by 18½", one operator can tend up to four machines placed side by side.

MODEL SM
TOROIDAL WINDER

The first and only toroidal coil winding machine ever manufactured to wind toroids down to 1/16 of an inch ID. Speed is variable from 0 to 800 RPM, handles wire sizes #36 through #50 AWG. Features completely automatic operation, continuously variable shuttle speed, segmental and 360 degree winding, predetermined length-of-wire and turns counting, one-hand control to insert core and remove finished coil, mechanical core holder, automatic core rotation, dynamic braking, and variable wire spacing.

MODEL BPA
PERMEAMETER

Assure product uniformity and eliminate cost of trimming coils to inductance. This unique instrument grades toroidal cores before winding . . . meter displays percentage-of-nominal-turns deviation from standard . . . operator winds correct number of turns to obtain proper inductance for each coil even though core permeability varies from core to core. Available with either air- or manually-operated fixture, handles cores ranging in permeability from 14 to 125 and sizes from 0.3" ID to 5.28" OD. Overall accuracy is 0.25%; large meter reads to 0.1%.

Write for complete catalog today. Watch Boesch this year for important new developments.

Boesch Manufacturing Co., Inc. Danbury, Conn.

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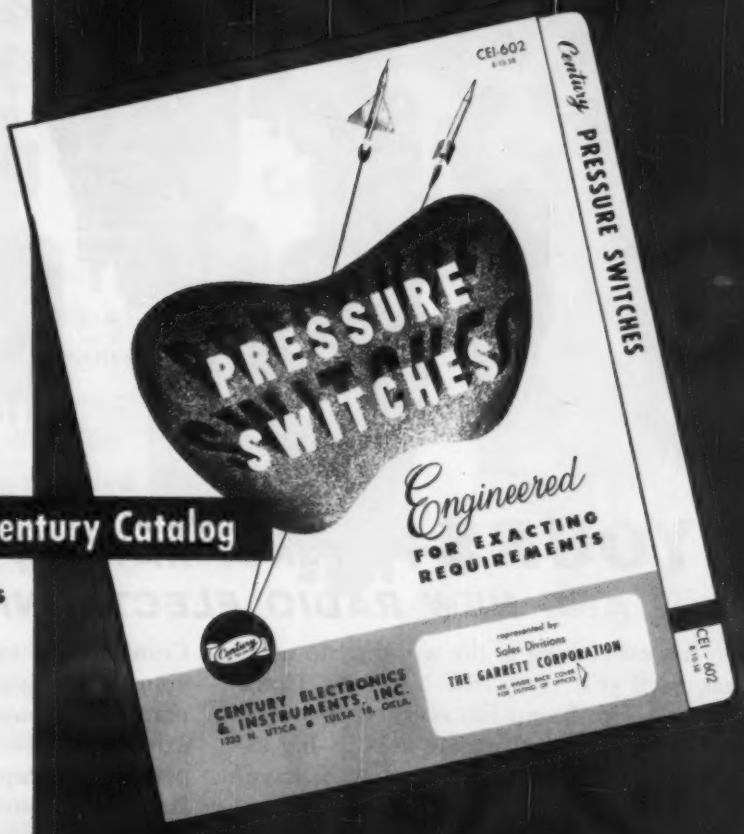
CIRCLE 41 READERS SERVICE CARD→

MR. ENGINEER:

Century PRESSURE SWITCHES



You Need This NEW Century Catalog

of Precision Pressure Switches

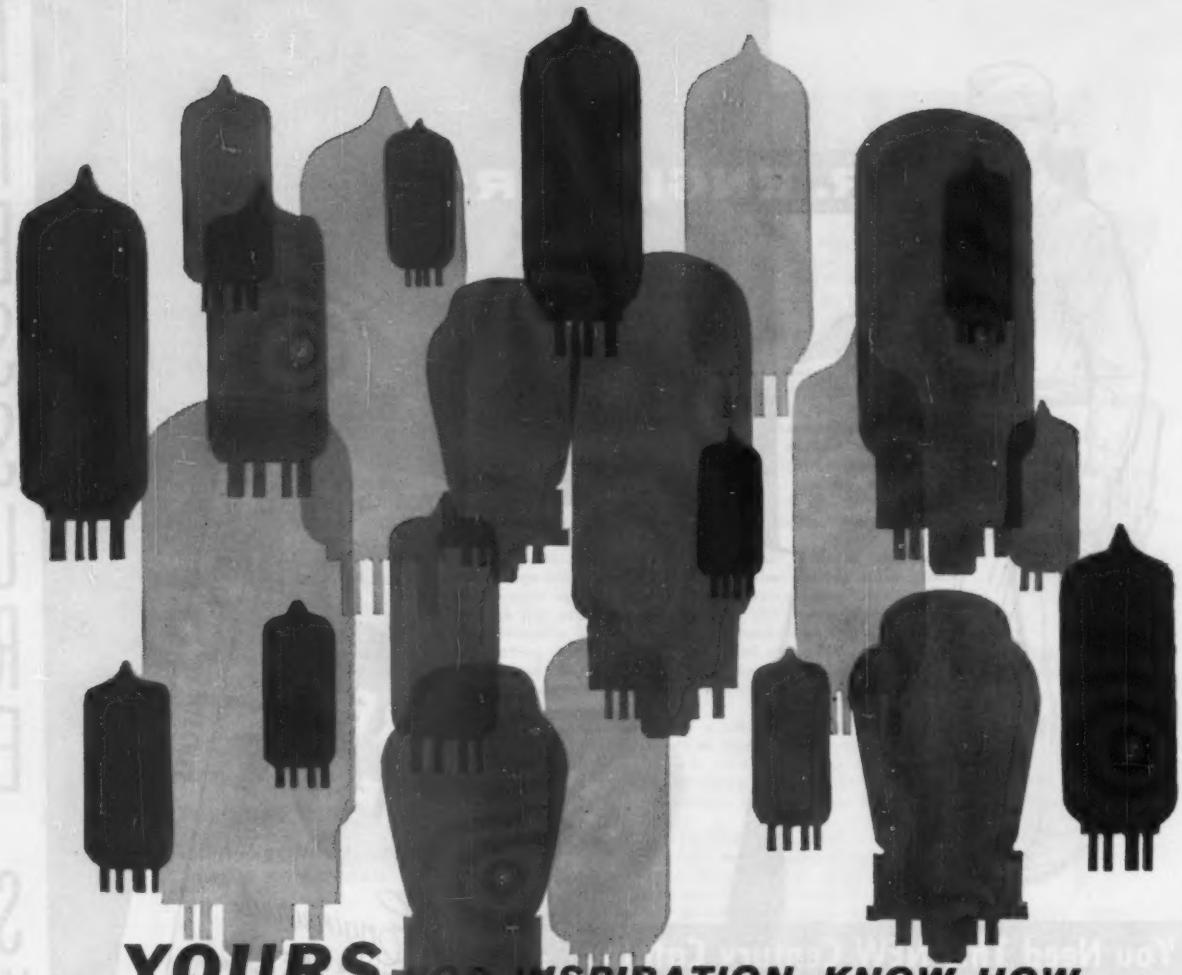
by

Century

CENTURY ELECTRONICS & INSTRUMENTS, INC.

There is a Century pressure switch precision engineered for every industrial, research, and military application.

PRESSURE SWITCHES



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Bigness has everything in the world to do with it when, each year, THE IRE NATIONAL CONVENTION and THE RADIO ENGINEERING SHOW is planned for you. Industries are only as big as you men who make them. And you have created a colossus that requires a Coliseum to show itself.

Come to see, to hear and to learn. Whatever your special interests—equipment, component parts, instruments or production—these 800 exhibits representing 80% of your industry's productive capacity are an INSPIRATION IN RADIO ELECTRONICS that will take you further along your personal path of progress.

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ALSIMAG® Alumina Ceramics

Industry-approved AlSiMag Aluminas are doing an outstanding job in more and more exacting applications calling for **superior electrical characteristics** at high temperatures and frequencies . . . **rugged** resistance to mechanical shock and vibration . . . **chemical inertness . . . resistance to repeated hot-cold shock.** AlSiMag Alumina ceramics are **hard,** measuring 9 on Mohs' scale . . . **strong,** offering extremely high compressive, flexural and tensile strengths. **Precision tolerances** can be maintained. Can be supplied in any quantity.

Write for free copy of Bulletin No. 562 which gives complete details on the most popular of the wide range of special-characteristic AlSiMag Aluminas available.

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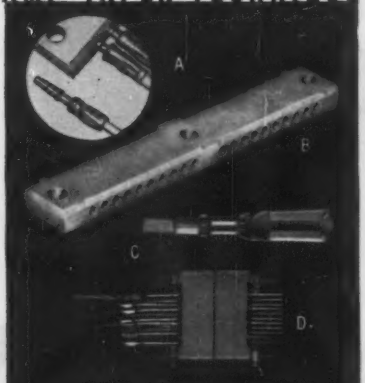
CHATTANOOGA 5, TENN.
A Subsidiary of Minnesota Mining and Manufacturing Company
57TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Mfg. Co. in these cities (see your local telephone directory): Atlanta, Ga. • Boston: Newton Center, Mass. • Buffalo, N. Y. • Chicago: Bedford Park, Ill. • Cincinnati, O. • Cleveland, O. • Dallas, Texas • Detroit, Mich. • High Point, N. C. • Los Angeles, Cal. • New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash. Canada: Minnesota Mining & Mfg. of Canada, Ltd., P. O. Box 757, London, Ont. All other export: Minnesota Mining & Mfg. Co., Internat'l. Div., 99 Park Ave., New York, N. Y.

FOR BETTER WIRE TERMINATING

AMP TAPER TECHNIQUE



(A) **A-MP "53" SERIES TAPER PINS** . . . insulated solid, screw machined or uninsulated formed pins to mate with tapered receptacles. Both types provide noise-free, low resistance electrical characteristics.

(B) **A-MP "53" SERIES TAPER BLOCKS** . . . are available in either solid blocks or two piece blocks . . . 10 or 20 cavity series . . . single or dual insert.

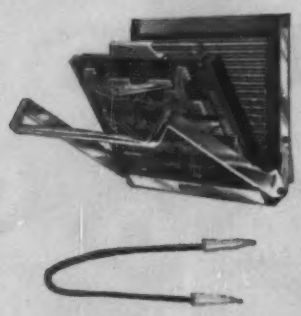
(C) **A-MP TAPER TAB RECEPTACLES** . . . accommodate flat tabs employing the taper key principle . . . feature standardized tapered section to fit relays, stepping switches, multiple connectors and other electronic components.

(D) **A-MP MINIATURE TAPER PIN RECEPTACLES** . . . eliminate tedious and costly operations of soldering leads to miniature connectors . . . use A-MP "37" Series Pins.

Bulletin Number 77

CIRCLE 150 READERS SERVICE CARD

AMP PATCHBOARD TECHNIQUE



A-MP PATCHCORD PROGRAMMING SYSTEMS AND PANELS offer tremendous versatility and flexibility. Exclusive feature of A-MP Systems is wiping action of pins against springs for clean contacts. A-MP Universal Patchcord Programming Systems and Panels are excellent for digital computers, data processing equipment and automatic test equipment. A-MP Shielded Patchcord Programming Systems and Panels are excellent for analog computers, telemetering equipment, test equipment and other low level applications where reliable shielding is required. Patchcords are made in a complete series for all programming requirements.

A-MP "240" SYSTEMS . . . offer complete reprogramming in seconds in airborne applications. The compact "240" System weighs 3¼ pounds and features 240 patchcord receptacles for maximum program combinations. It, too, features the exclusive wiping action to assure optimum electrical contact at all times.

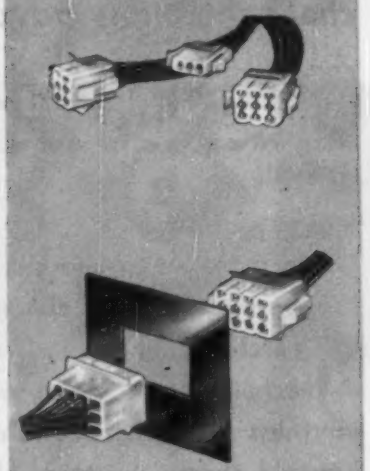
Bulletin Number 58

CIRCLE 151 READERS SERVICE CARD

Information concerning any termination problem will be forwarded on request. For literature on the above products, write, giving bulletin numbers desired, to:

AMP

AMP-Lok MULTIPLE CONNECTORS



AMP-LOK CONNECTORS . . . are made in 3, 6, 9, or 12 circuit units . . . the most versatile multiple connectors available to the electronics industry. Self anchoring units require no extra mounting parts for through-panel applications. All contacts are identical and self cleaning . . . recessed for safety. Finger grip engagement and disengagement of housing which is polarized to eliminate circuit error. AMP-lok will accommodate a wide range of panel thicknesses . . . may be color coded. AMP-lok may also be used with complete safety as a free hanging multiple connector.

Bulletin Number 45

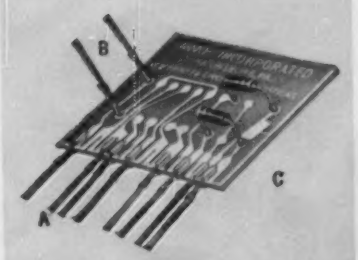
CIRCLE 152 READERS SERVICE CARD

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

TECHNIQUES . . . SPECIFY AMP

PRINTED CIRCUIT TECHNIQUE



(A) AMP-EDGE TERMINALS . . . assure excellent electrical contact with friction grippage and positive wiping action . . . apply easily to any section of the perimeter of the printed circuit board . . . reduce cost of application to wire conductor and to board.

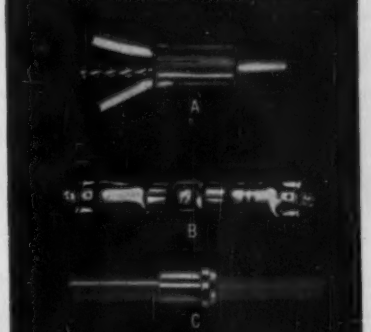
(B) AMPin TERMINALS . . . eliminate loose leads during solder-dip operation . . . promote good capillary action during solder dipping . . . accommodate solid or stranded conductors . . . are self retaining and self-aligning.

(C) AMP COMPONENT TIPS . . . prevent movement of components during solder dipping cycle . . . permit bridging or offsetting of components . . . protect semi-conductor leads from solder dipping heat . . . eliminate need for eyelets and thru-plating on two-sided boards, by excellent solder wicking characteristics and uniform solder deposit.

Bulletin Number 81

CIRCLE 153 READERS SERVICE CARD

SHIELDED WIRE PRODUCTS



(A) TERMASHIELD SHIELDED WIRE FERRULES . . . assure positive grounding of wire shield . . . eliminate solder-danger of burning insulation and uncertain attachment . . . feature one-piece construction . . . accommodate one or more grounding wires.

(B) TERMASHIELD SHIELDED WIRE SPLICES join sections of shielded wire so that both the inner conductors and outer shields are firmly spliced, with the two effectively insulated. They eliminate multi-stage assembly or soldering . . . color coded for matching with application tooling and wire sizes.

(C) TERMASHIELD 7MM SHIELDED CABLE FERRULES . . . permanently ground shielded high tension cables . . . prevent wire damage during attachment . . . won't loosen or vibrate to cause poor ground or rf noise . . . remove danger of sparking . . . offer easy, four-step attachment . . . seat precisely into applicable joints.

Bulletin Number 24

CIRCLE 154 READERS SERVICE CARD

TERMINALS AND SPLICES

(A) STRATO-THERM TERMINALS AND SPLICES . . . for high temperature and heat resistant requirements . . . accommodate a wide range of wire sizes either solid or stranded or both . . . with or without fully circumferential wire insulation support as desired.

(B) CERTI-SEAL MOISTURE PROOF WINDOW SPLICES . . . seal out vapors and fluids even at altitude to assure dry splice . . . accommodate over 100 insulation thicknesses . . . resist heavy vibration and shock.

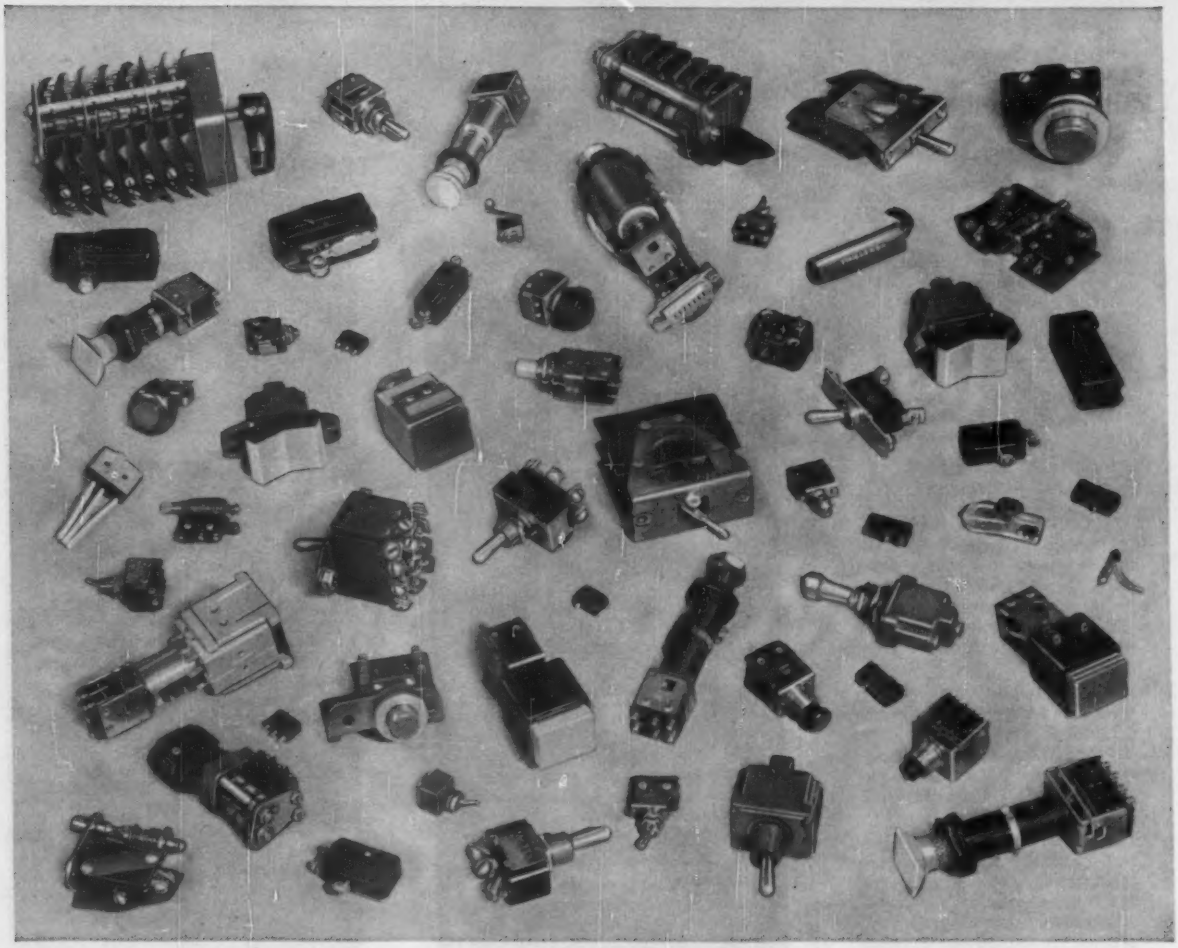
(C) OTHER A-MP TERMINALS AND SPLICES . . . designed for the most diverse circuitry requirements . . . stringently tested for corrosion resistance, vibration resistance, conductivity and long life . . . ideal for all types of electronic equipment.

Bulletin Number 87

CIRCLE 155 READERS SERVICE CARD

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

MICRO SWITCH Precision Switches



Precision switches for every design requirement ... plus nationwide topflight engineering service

The very variety of shapes and sizes, actuators and mountings of the sixty or so switches illustrated here may suggest an answer to a switching problem. And these switches suggest the scope of the MICRO SWITCH precision switch line, numbering thousands of switches with mechanical and electrical characteristics to meet nearly any need.

Control of quality is as complete as the line itself. Successful development of precise, reliable switching components has made MICRO SWITCH the leader in the industry.

And, to complete the picture of MICRO SWITCH as your best first source for precision switches, the competent counsel of MICRO SWITCH field engineers in branch offices across the country is available to help you save time in switch selection.

You are invited to call the branch office near you for information about any of the switches shown, or for help on a specific problem. Consult the Yellow Pages.

MICRO SWITCH ... FREEPORT, ILLINOIS

A division of Honeywell

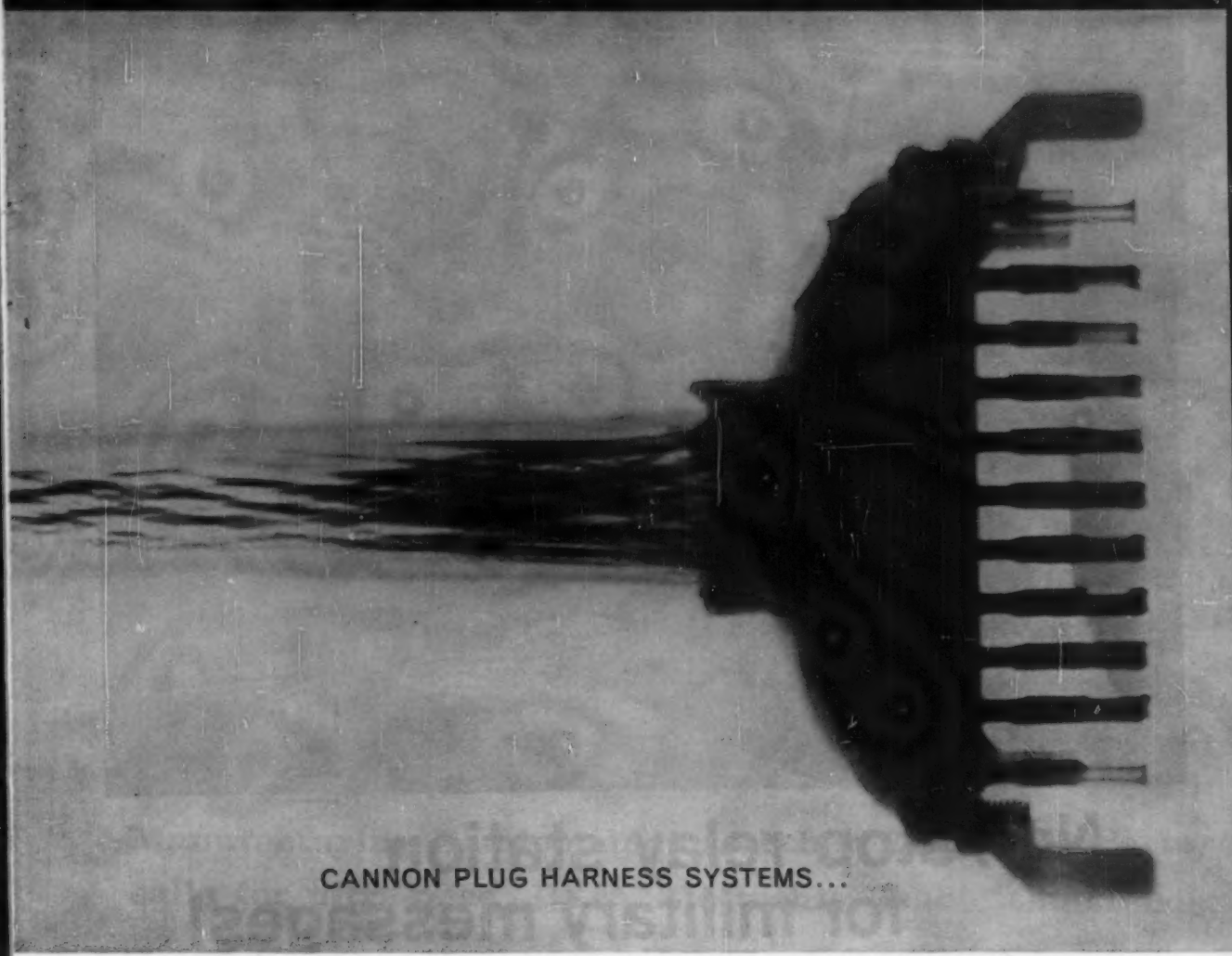
In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario

Honeywell

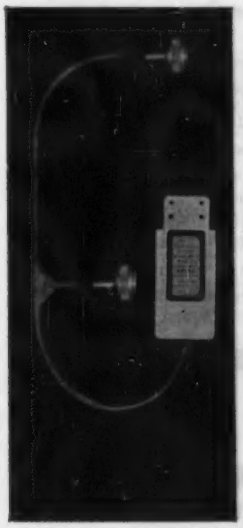
MICRO SWITCH PRECISION SWITCHES

CIRCLE 46 READERS SERVICE CARD

CIRCLE 47 READERS SERVICE CARD→



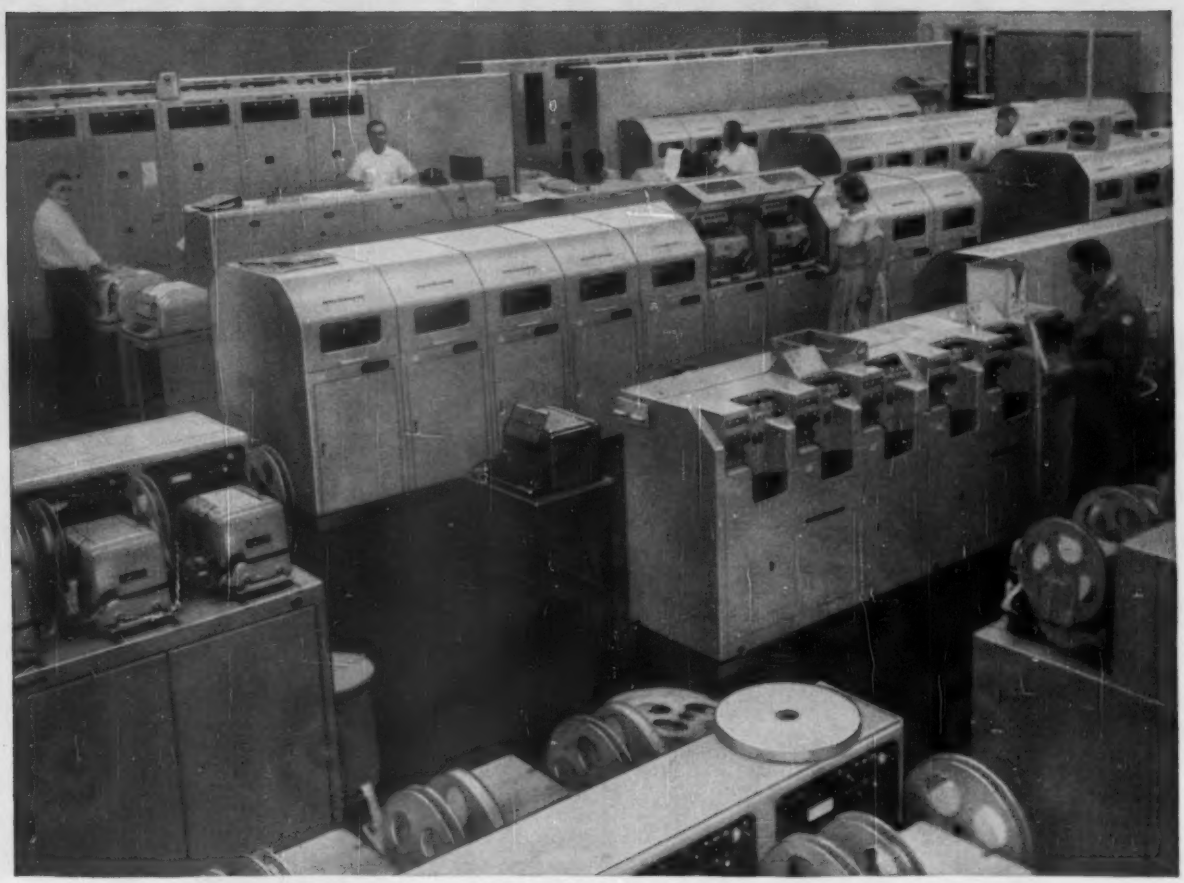
CANNON PLUG HARNESS SYSTEMS...



AN EXTENSION OF RELIABILITY...Cannon Plug Harness Systems feature MS, or other specified plugs, and cables as *one complete unit*—extending the Cannon responsibility to the cable system as a whole. Supplementing its capabilities as the world's largest manufacturer of electrical plugs Cannon Electric has filled the need for greater reliability by pioneering custom "harnessed plug systems" for such companies as Douglas Aircraft. Cannon facilities perform all phases of development, from engineering through model and pilot fabrication and provide a single source of supply for both plugs and harness assemblies. The extensive testing laboratories assure ready-for-installation deliveries with no pyramiding of costs and a maximum of reliability. Write for Harness Catalog HC-1. Cannon Electric Company—3208 Humboldt Street, Los Angeles 31, California. Please refer to Department 120. Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne and Tokyo. Distributors and Representatives in all of the principal cities of the world.

CANNON PLUGS

MARCA REG. EN MEXICO



Non-stop relay station for military messages!

Kleinschmidt equipment receives and instantly re-transmits thousands of printed communications daily at the Army's Switching Center, Davis, California.

At one of the largest installations in the U. S. Army's teletypewriter network, Kleinschmidt reperforator-transmitters, teletypewriters and related equipment, developed in cooperation with the U. S. Army Signal Corps, receive and automatically relay the vast load of military communications for the Pacific overseas area and western United States. With related switching equipment, incoming messages are scanned and re-transmitted without manual handling . . . so rapidly that the first portion of a relayed message is received at its destination before the latter part has been transmitted from point of origin!

Research and development of equipment for transmitting and receiving printed communications has been a continuing project at Kleinschmidt for almost 60 years. This unparalleled store of experience, now joined with that of Smith-Corona Inc, holds promise of immeasurable new advances in electronic communications.

KLEINSCHMIDT

DIVISION OF SMITH-CORONA MARCHANT INC., DEERFIELD, ILL.

Pioneer in teleprinted communications systems and equipment since 1911

Manufacturing Semiconductors, other Electronic Parts calls for ultra-pure B&A® "Electronic Grade" Chemicals

Impurities in the chemicals you use may be a hidden cause of poor quality and high rejection ratios for semiconductors and other electronic parts. That's why you need ultra-pure B&A "Electronic Grade" chemicals. Developed especially for the electronic industry by America's leading producer of laboratory and scientific chemicals — Baker & Adamson—they are distinguished by carefully controlled assay and remarkably low limits on impurities.

For example: the exceptional purity of B&A "Electronic Grade" Solvents is made possible through a new analytical technique involving resistivity measurements to detect and control trace impurities. This special quality control method for B&A "Electronic Grade" solvents eliminates one more variable in the production of electronic devices and significantly reduces rejection ratios.

Many B&A "Electronic Grade" chemicals are now available. They are listed here. To meet special needs, other high purity chemicals can be custom-made to your specifications.

B&A "ELECTRONIC GRADE" CHEMICALS

Acetone
Aluminum Nitrate, Crystal and Basic
Barium Acetate
Barium Nitrate
Calcium Nitrate, Tetrahydrate
Carbon Tetrachloride
Ether, Anhydrous
Hydrofluoric Acid, 48%
Hydrogen Peroxide, 3%
Hydrogen Peroxide, 30%
Hydrogen Peroxide, 30% "Stabilized"
Methyl Alcohol, Absolute (Methanol) "Acetone Free"
Propyl Alcohol, Iso
Sodium Carbonate, Monohydrate
Strontium Nitrate
Trichloroethylene

Other B&A chemicals for electronics include:

High purity Germanium—Dioxide, First Reduction Metal, Intrinsic Metal
Metallic oxides, carbonates and oxalates for ferrite cores
Fluoborates for plating printed circuits
Sulfur Hexafluoride for gaseous insulation

Write today for free folder on B&A "Electronic Grade" chemicals.

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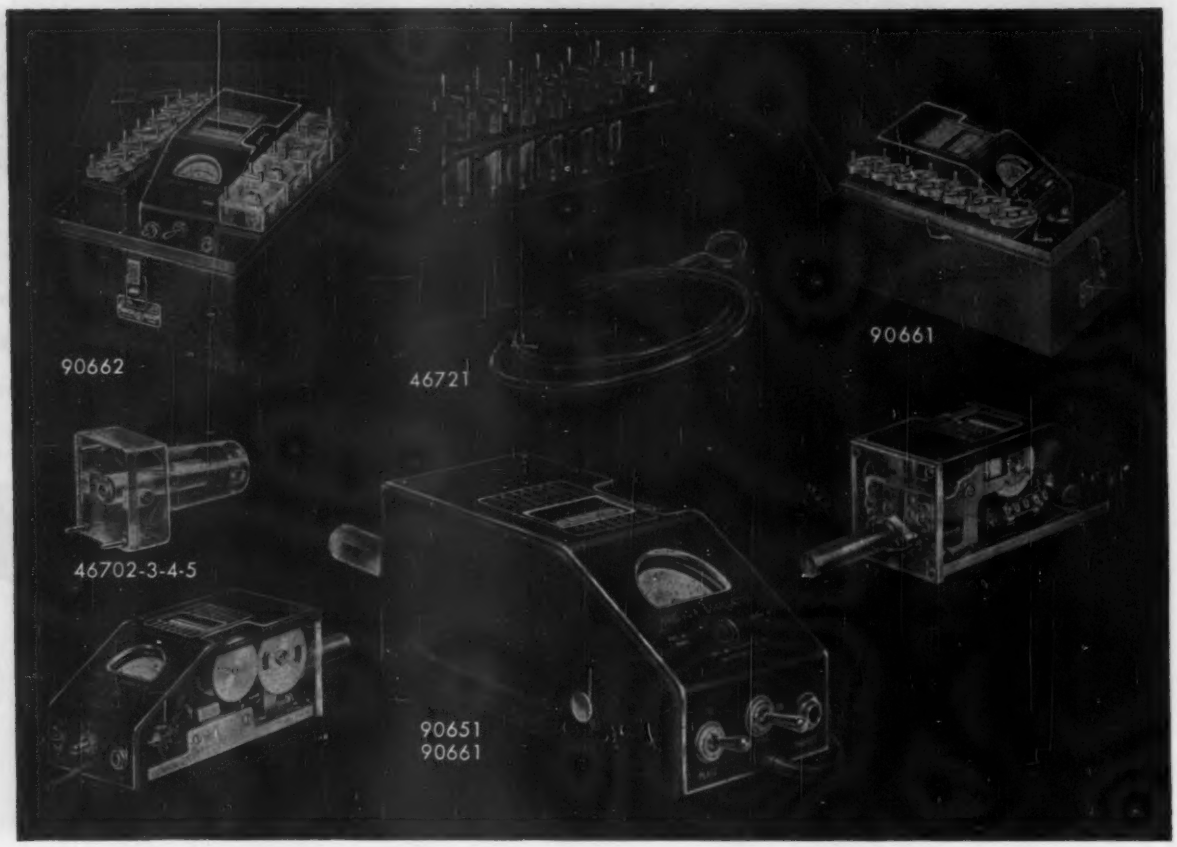
Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.



Designed for Application

Grid Dip Meters

Millen Grid Dip Meters are available to meet all various laboratory and servicing requirements.

The 90662 Industrial Grid Dip Meter completely calibrated for laboratory use with a range from 225 kc. to 300 mc. incorporates features desired for both industrial and laboratory application, including three wire grounding type power cord and suitable carrying case.

The 90661 Industrial Grid Dip Meter is similar to the 90662 except for a reduced range o 1.7 to 300 mc. It likewise incorporates the three wire grounding type cord and metal carrying case.

The 90651 Standard Grid Dip Meter is a somewhat less expensive version of the grid dip meter. The calibration while adequate for general usage is not as complete as in the case of the industrial model. It is supplied without grounding lead and without carrying case. The range is 1.7 to 300 mc. Extra inductors available extends range to 220 kc.

The Millen Grid Dip Meter is a calibrated stable RF oscillator unit with a meter to read grid current. The frequency determining coil is plugged into the unit so that it may be used as a probe.

These instruments are complete with a built-in transformer type A.C. power supply and internal terminal board to provide connections for battery operation where it is desirable to use the unit on antenna measurements and other usages where A.C. power is not available. Compactness has been achieved without loss of performance or convenience of usage. The incorporation of the power supply, oscillator and probe into a single unit provides a convenient device for checking all types of circuits. The indicating instrument is a standard 2 inch General Electric instrument with an easy to read scale. The calibrated dial is a large 205° drum dial which provides seven direct reading scales, plus an additional universal scale, all with the same length and readability. Each range has its individual plug-in probe completely enclosed in a contour fitting polystyrene case for assurance of permanence of calibration as well as to prevent any possibility of mechanical damage or of unintentional contact with the components of the circuit being tested.

The Gride Dip Meters may be used as:

1. A grid Dip Oscillator
2. An Oscillating Detector
3. A Signal Generator
4. An Indicating Absorption Wavemeter

The most common usage of the Grid Dip Meter is as an oscillating frequency meter to determine the resonant frequencies of de-energized tuned circuits.

Size of Grid Dip Meter only (less probe): 7 in. x 3¹¹⁄₁₆ in. x 3⅜ in.

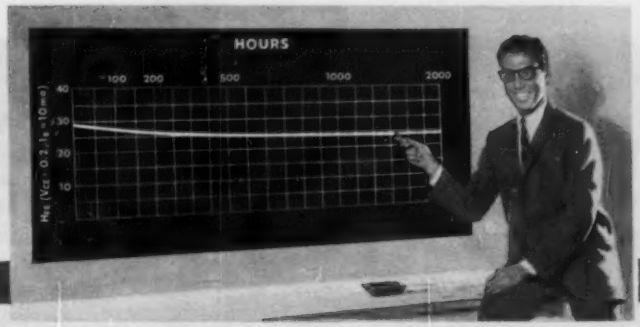
JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U.S.A.

Now PNP SWITCHING TRANSISTORS from Sylvania

2N404
2N425
2N426
2N427
2N428



designed to give you this same reliability you've come to expect from Sylvania's full line of NPN types

HERE IS an important line of PNP switching transistors to complement Sylvania's line of NPN types. Manufacturing techniques developed for producing high-temperature stability in NPN types have been incorporated in these new PNP switching transistors. For designers this means the high reliability and stability synonymous with Sylvania NPN types, and permits circuit designs which take full advantage of the complementary aspects of NPN and PNP.

These transistors feature a new hermetically sealed inverted base TO-5 package which offers better heat dissipation to easily provide up to 150 mw at 25°C.

Electrical, mechanical, and environmental tests applied to these PNP transistors are in accordance with MIL-T-19500A.

TECHNICAL DATA

Type	V_{CB} Volts	V_{EB} Volts	V_{CE} Volts	f_{ab} min mc	h_{FE} Typical	Max. Dissipation in MW
2N404	−25	−12	−24	4.0	50	120
2N425	−30	−20	−20	2.5	30	150
2N426	−30	−20	−18	3.0	40	150
2N427	−30	−20	−15	5.0	55	150
2N428	−30	−20	−12	10.0	80	150

Temperature range −65°C to +85°C

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N.Y.
In Canada: P.O. Box 1190, Station "O" Montreal 9

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

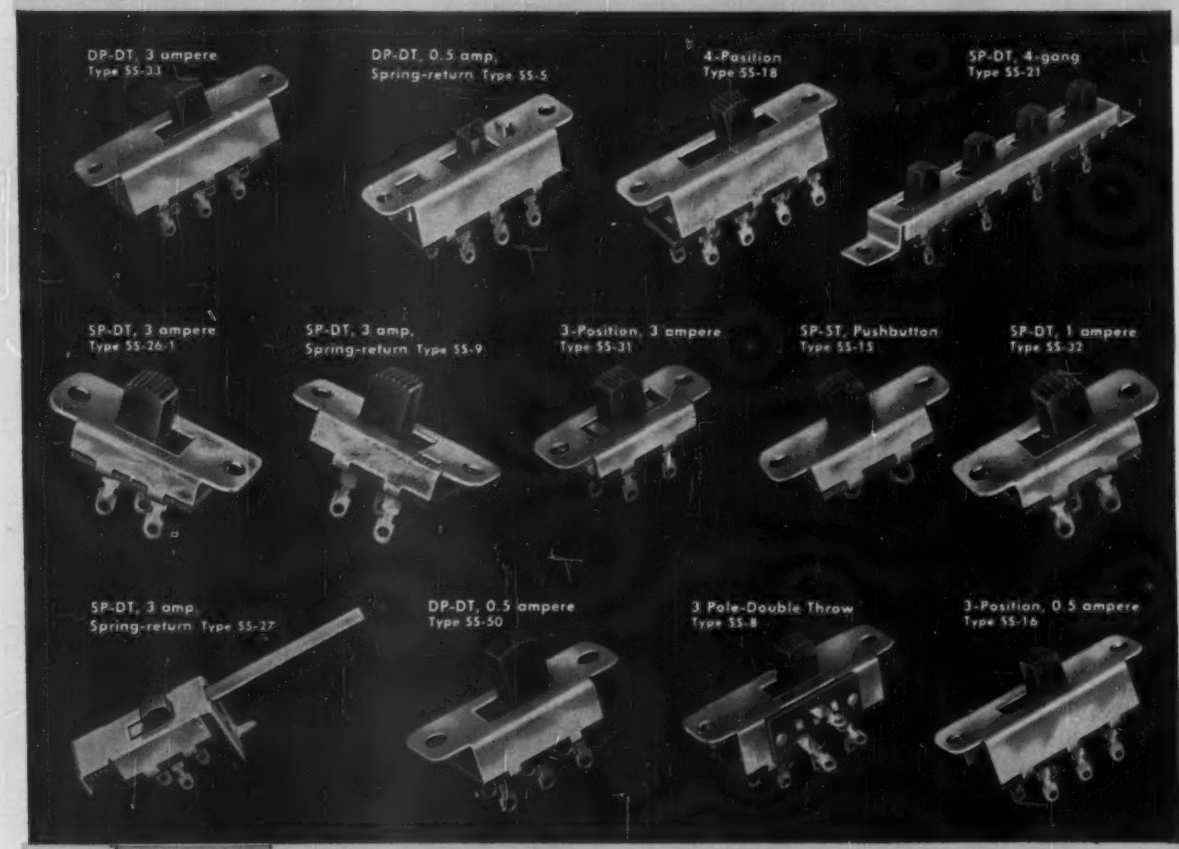
for UNIQUE, LOW-

Sturdy little Stackpole Slide Switches provide almost any desired switching arrangement at rock-bottom cost.

Features include ½-, 1- and 3-ampere, 125 volt ratings in U.L. Inspected types; 1- to 4-pole types with up to 4 positions; momentary or maintained contact designs; lug, printed wiring or solderless-wrap terminals; and many special types such as plunger-operated, spring-return, 4-gang, and many more.

Complete details are in Stackpole Bulletin RC-11D. Send for your copy to: Electronic Components Div., STACKPOLE CARBON COMPANY, St. Marys, Pa.

17 BASIC TYPES...*the most complete line*



Coldite 70-I® fixed composition resistors • Snap and Slide Switches • Ceramag® ferromagnetic cores
Variable composition resistors • Ceramagnet® ceramic magnets • Fixed composition capacitors
Brushes for all rotating electrical equipment • Electrical contacts • Hundreds of related carbon graphite and metal powder products.

COST SWITCHING ARRANGEMENTS

. . . for radio and television receivers, audio equipment, instruments, toys, motorized appliances . . . and a host of other electrical and electronic uses.

8 New Knob Colors

. . . A Modern Touch in Slide Switches

Pacing trends in modern decorative styling, the molded plastic knobs of Stackpole Slide Switches are now available in a variety of attractive colors. Priced scarcely higher than types with black knobs, the new switches are designed to harmonize or lend greater visibility and emphasis to important switch functions.

TOPS FOR PRINTED CIRCUITS—All Stackpole Slide Switches can be supplied with special gold-coated terminals for quick assembly in modern dip-soldered printed circuit chassis.

TERMINALS SHIELDS—Snap-on, fibre-insulated shields are available for most Stackpole switches when necessary to meet U. L. requirements or to shield audio circuits against stray a-c fields.

STACKPOLE
SLIDE SWITCHES

Sierra 185A-15FN Wattmeter

Sierra 164 Power Monitor

Swift, simple, accurate

WATTMETERS

Average-reading termination instruments — 15 to 500 watts; 20 MC to 1,000 MC

POWER MONITORS

Bi-directional; measure incident or reflected power; 10 MC to 1,000 MC

Sierra Termination Wattmeters and Bi-directional Power Monitors are specifically engineered for convenient, accurate measurement of rf power, incident and reflected power; matching antennas and loads; and terminating rf coaxial systems.

Three Model 185A series Average-Reading Termination Wattmeters cover three power ranges as indicated under "Specifications". These rugged, dependable instruments require no auxiliary power source, and are ideal dummy loads for testing and adjusting CW, AM and FM transmitters and oscillators. They are conservatively rated, with negligible rf leakage.

Sierra 164 series Bi-directional Power Monitors are direct-reading, versatile instruments covering 10 MC to 1,000 MC with as few as two plug-in elements. A wide selection of plug-ins permits measurement of incident or reflected powers over all ranges from 1 to 1,000 watts. Reversal of power flow is achieved simply by turning a control knob on the plug-in element in use. High directivity and low VSWR insure maximum accuracy with minimum disturbance to the transmission line under test.

SPECIFICATIONS

SIERRA 185A SERIES WATTMETERS

Model	Frequency	Power Range, Watts	Max. Power Dissipation
185A-15FN	20 MC - 1,000 MC	0 - 5/15	15 watts
185A-100FN	20 MC - 1,000 MC	0 - 30/10	100 watts
185A-500FN	20 MC - 1,000 MC	0 - 150/500	500 watts

Accuracy ±5% full scale. Max. VSWR 1.2. Type N female connectors standard.

SIERRA 164 SERIES POWER MONITORS

(Monitors require plug-in element for operation. See 180/181/270 Series data below)

Insertion VSWR:	Less than 1.08 except on 1 watt ranges; less than 1.15 on 1 watt (with Type N connector)
Accuracy:	±5% full scale, all ranges
Impedance:	50 ohm coaxial line
Weight:	7½ lbs., with 1 plug-in
Connectors:	N, UHF or C*. (*Special order)

SIERRA POWER MONITOR PLUG-INS

Model	Power Ranges	Frequency Range
180-52	1, 5, 10, 50 watts	25 MC to 52 MC
180-148	1, 5, 10, 50 watts	50 MC to 148 MC
180-470	1, 5, 10, 50 watts	144 MC to 470 MC
180-1000	1, 5, 10, 50 watts	460 MC to 1,000 MC
181-250	10, 50, 100, 500 watts	25 MC to 250 MC
181-1000	10, 50, 100, 500 watts	200 MC to 1,000 MC
270-75	50, 100, 500, 1,000 watts	10 MC to 75 MC

Data subject to change without notice

SIERRA ELECTRONIC CORPORATION

A SUBSIDIARY OF PHILCO CORPORATION

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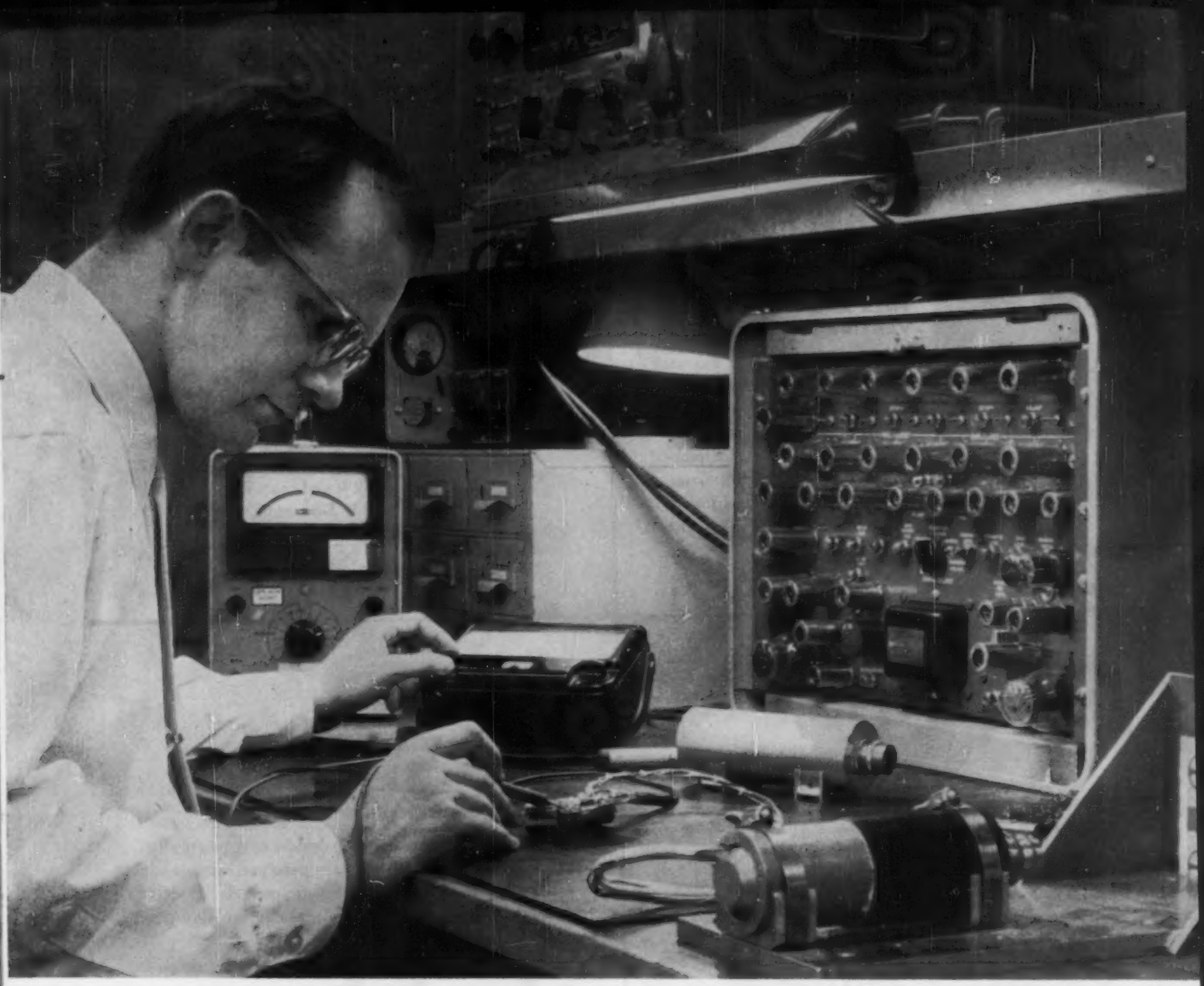
SALES REPRESENTATIVES IN MAJOR CITIES

sierra

CIRCLE 54 READERS SERVICE CARD



A MISSILE AND TELEVISION INDUSTRY FIRST. Lockheed-developed, miniaturized TV cameras, designed for both government and commercial use. Only 6 inches long and 2¼ inches in diameter, tiny cameras extend man's vision into the unexplored. Unmanned lunar probes to the far side of the moon; lunar landings; monitoring interiors of manned spacecraft and remote TV coverage of on-the-spot happenings on a scope never before possible are some of the uses foreseen for the cameras.

ELECTRONIC ENGINEERS AND SCIENTISTS

Lockheed Missile Systems Division is systems manager for such major, long-range programs as the Navy Polaris IRBM, Earth Satellite, Army Kingfisher, Air Force X-7 and Q-5 ramjet vehicles, and other important research and development programs.

Responsible positions for high-level, experienced personnel are available in research and development, in our project organizations, and in manufacturing.

Particular areas of interest include microwave, telemetry, radar, guidance, solid state, reliability, data processing, instrumentation, servomechanisms, flight controls, circuit design and systems analysis, test, infrared, and optics.

If you hold a degree and are experienced in one of the above fields, we invite your inquiry. Please write to Research and Development Staff, Dept. 2212, 962 W. El Camino Real, Sunnyvale, California.

Lockheed

MISSILE SYSTEMS DIVISION

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Guidance and Control Instruments by Humphrey

FREE AND VERTICAL GYROS

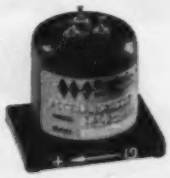
New interchangeable motors make it possible to power these instruments with d-c, 400-cycle a-c or 1500-cycle inverter. Offered with a variety of pick-offs, including potentiometer, synchro or switch. Electrical or manual caging.

RATE GYROS

The Humphrey design provides a wide dynamic range with precision potentiometer or variable transformer output. Three basic units available, all in hermetically sealed cases with choice of a-c or d-c motors.

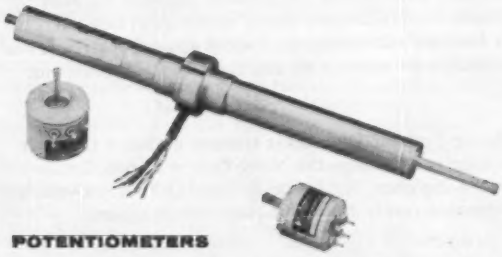
RATE SWITCHES

These specialized gyros operate switches when a predetermined rate of turn is reached. Extremely light weight. Dry gas filled and employing dry gas dampers that remain constant over full temperature range. Wide selection of rates available.



ACCELEROMETERS

These precision inertial sensing devices offer practically zero cross-talk, extra wide temperature range and precision potentiometer or magnetic pickoffs. Models available for angular or linear measurement. Dry gas damped, hermetically sealed.



POTENTIOMETERS

Precision rectilinear and rotary instruments. Wire wound. For direct mounting in aircraft or missiles. Operational to 400°F. Able to take tough environmental conditions, such as vibration 25G, 10 to 2,000 cps, and shock of 100G while operating.

NEW SERVOTRAN VARIABLE SPEED DRIVE

Offers frequency response equivalent to a hydraulic system and triple that of an electrical system in a dependable mechanical drive weighing only 1¾ lbs. A maximum of only two inch ounces on the control shaft changes speed from full forward to full reverse in .05 second. Ideal for actuators, computers, recorders and radar antennas.

Humphrey Inc.

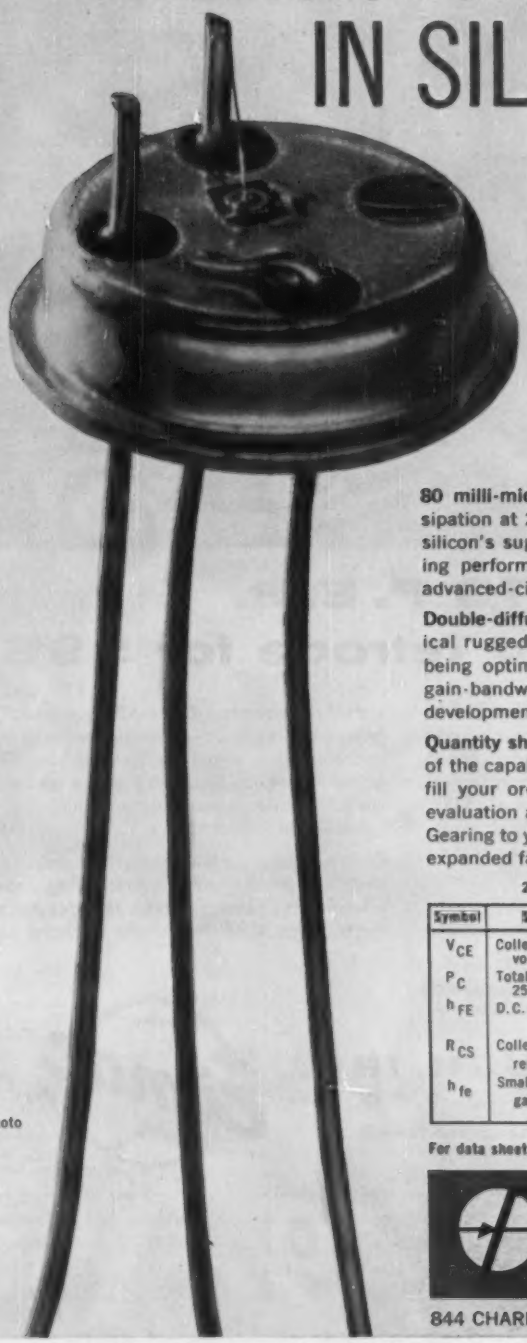
ELECTRO-MECHANICAL INSTRUMENTS

DEPT. E-128, 2805 CANON STREET
SAN DIEGO 6, CALIFORNIA

WRITE TODAY FOR MORE INFORMATION ON ANY OF THESE PRODUCTS

FROM FAIRCHILD

MESA TRANSISTORS IN SILICON



Greatly enlarged photo of Fairchild 2N696 before capping

80 milli-micro-second rise time with 2 watts power dissipation at 25° C. This speed and power is combined with silicon's superior high-temperature reliability. The switching performance that this affords has a place in every advanced-circuit evaluation program.

Double-diffused mesa-type construction provides mechanical ruggedness and excellent heat dissipation besides being optimum for high-frequency performance (typical gain-bandwidth product 80 Mc). This type is under intense development everywhere. Fairchild has it in production.

Quantity shipments now being made give conclusive proof of the capabilities of Fairchild's staff and facilities. We can fill your orders promptly. You can start immediately on evaluation and building of complete prototype equipment. Gearing to your future production needs, Fairchild will have expanded facilities to over 80,000 square feet by early '59.

2N696 and 2N697 — NPN SILICON TRANSISTORS

Symbol	Specification	Rating	Characteristics	Test Conditions
V_{CE}	Collector to Emitter voltage (25° C.)	40v		
P_C	Total dissipation at 25° C. Case temp.	2 watts		
h_{FE}	D.C. current gain		2N696—15 min. 2N697—30 min.	I_C=150ma V_C=10v
R_{CS}	Collector saturation resistance		6Ω typical 10Ω max.	I_C=150ma I_B=15ma
h_{fe}	Small signal current gain at f=20Mc		4 typical	I_C=50ma V_C=10v

For data sheets, write Dept. A-12

FAIRCHILD SEMICONDUCTOR CORPORATION

844 CHARLESTON RD. • PALO ALTO, CALIF. • DA 6-6695

15,000 WATTS P. E. P.
New Ceramic Tetrode for SSB

Eimac's new, high-power 4CW10,000A is ideal for use in Class AB_1 single sideband service. This new tetrode is a water-cooled version of the widely-used Eimac 4CX5000A, with plate dissipation capability increased to 10,000 watts and a peak envelope power of 15,000 watts. Water-cooling makes the 4CW10,000A excellent for heavy duty applications where reserve plate dissipation is required.

Eimac offers the most complete line of tetrodes with the high-power gain, low distortion and excellent stability required in Class AB_1 operation. Each has proved reserve ability to handle the high peak powers encountered in single sideband service. Efficient integral-finned anode coolers on the air-cooled types keep blower requirements to a minimum, allowing compact equipment design.

Ceramic-metal design means compactness, ruggedness, high performance, and reliability. These proved advantages of Eimac ceramic tetrodes make possible more compact, efficient single sideband equipment.

Write our Application Engineering Department for a copy of the technical bulletin "Single Sideband."

EITEL-McCULLOUGH, INC.
SAN CARLOS, CALIFORNIA
Eimac First with ceramic tubes that can take it

Eimac®

Cable address
EIMAC
San Carlos

CLASS AB_1 SSB OPERATION

	4CX250B	4CX300A	4CX1000A	4CX5000A	4CW10,000A
Plate Voltage	2000 v	2500 v	3000 v	7500 v	7500 v
Driving Power	0 w	0 w	0 w	0 w	0 w
Peak Envelope Power	325 w	400 w	1680 w	10,000 w	15,000 w

CIRCLE 58 READERS SERVICE CARD

CIRCLE 59 READERS SERVICE CARD→

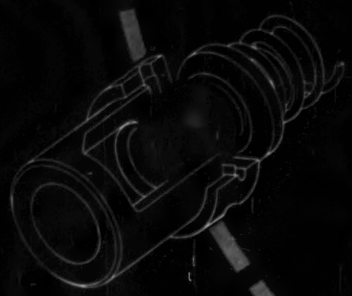
PERFECT SURFACE . . . EXTREME HARDNESS . . . LOW COST

—all this and more, with LINDE Sapphire!

To assure dependability under the most severe conditions, tiny valve poppets and seats of pilot relief valves for space vehicle tanks built by Whittaker Controls are made from LINDE Sapphire. LINDE Sapphire was selected over other materials for this critical use because of its perfectly smooth surface, extreme hardness, and relatively low cost. Other advantages are resistance to corrosion and fast deliveries from LINDE.

Among other properties of LINDE Sapphire are zero porosity, great strength at elevated temperatures, and a high melting point of 2040° C. LINDE Sapphire is transparent, may be clear or red. It is easily sealed to metals or ceramics and has excellent IR transmission characteristics.

LINDE Sapphire is supplied in the form of balls, rods, tubes, domes, and special shapes to order. For more information, write Crystals Department, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

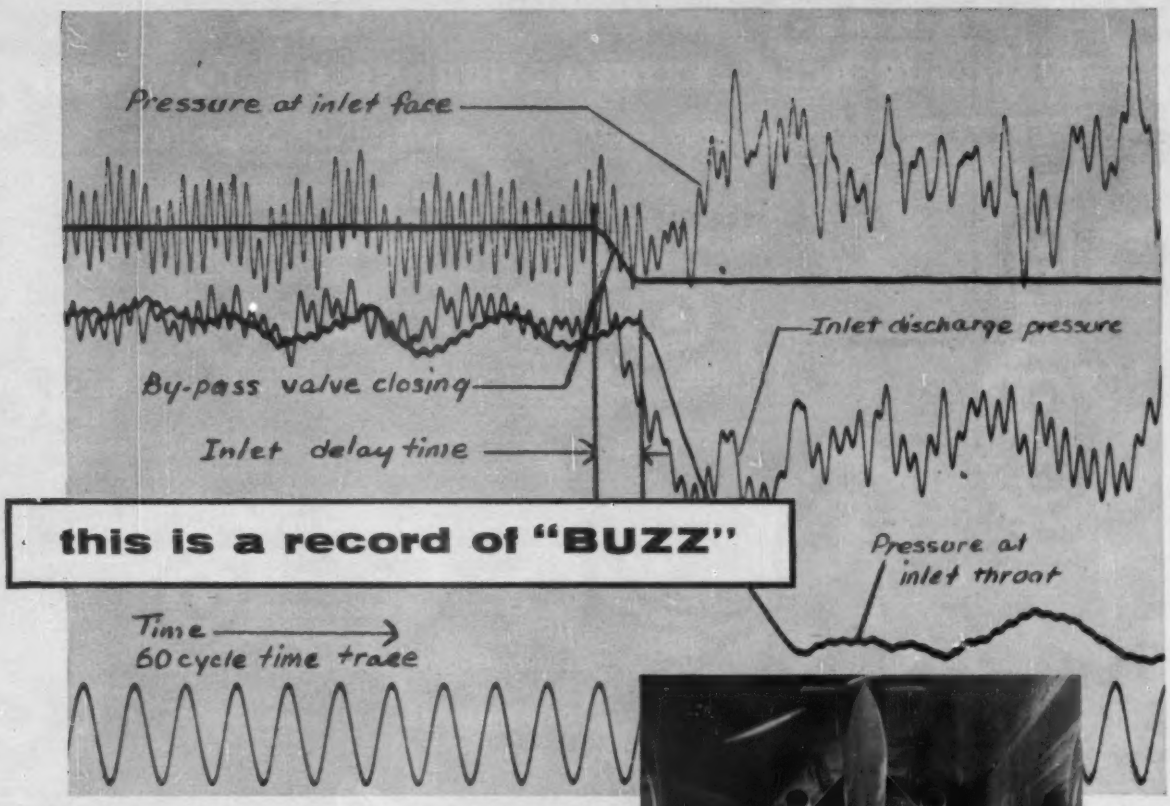


Pilot section of this pressure relief valve has poppet ball (red) and seat of LINDE Sapphire. Valve was designed and manufactured by Whittaker Controls Division of Telecomputing Corporation.

Linde
TRADE MARK

UNION CARBIDE

"Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation.



The Visicorder charts pressure fluctuations in a supersonic inlet

A Model 906 Honeywell Visicorder wrote this record of pressure fluctuations . . . "buzz" . . . for the National Advisory Committee for Aeronautics at the Lewis Flight Propulsion Laboratory in Cleveland. Buzz is the term used to describe unsteady variation in pressure and airflow characteristics of a supersonic aircraft or missile inlet.

The purpose of these Visicorder studies is to define the buzz-free operating limits of the inlet, and to provide the designer with structural load information in case the inlet is inadvertently caused to operate on buzz during flight. This is particularly important because inlet buzz can result in fluctuating structural loads of the order of 1000 psf. Depending on the inlet design, this could cause structural failure of the inlet and loss of the airplane.

High response pressure transducers are used to measure these fluctuating pressures and the resulting electrical signal is fed into the Visicorder. Records such as this are also necessary in the determination of the inlet dynamics such as delay time. This information is then used to design inlet control systems.

NACA Engineer examines Visicorder record

The HONEYWELL VISICORDER is the first high-frequency, high-sensitivity direct recording oscillograph. In laboratories and in the field everywhere, instantly-readable Visicorder records are pointing the way to new advances in product design, rocketry, computing, control, nucleonics . . . in any field where high speed variables are under study.

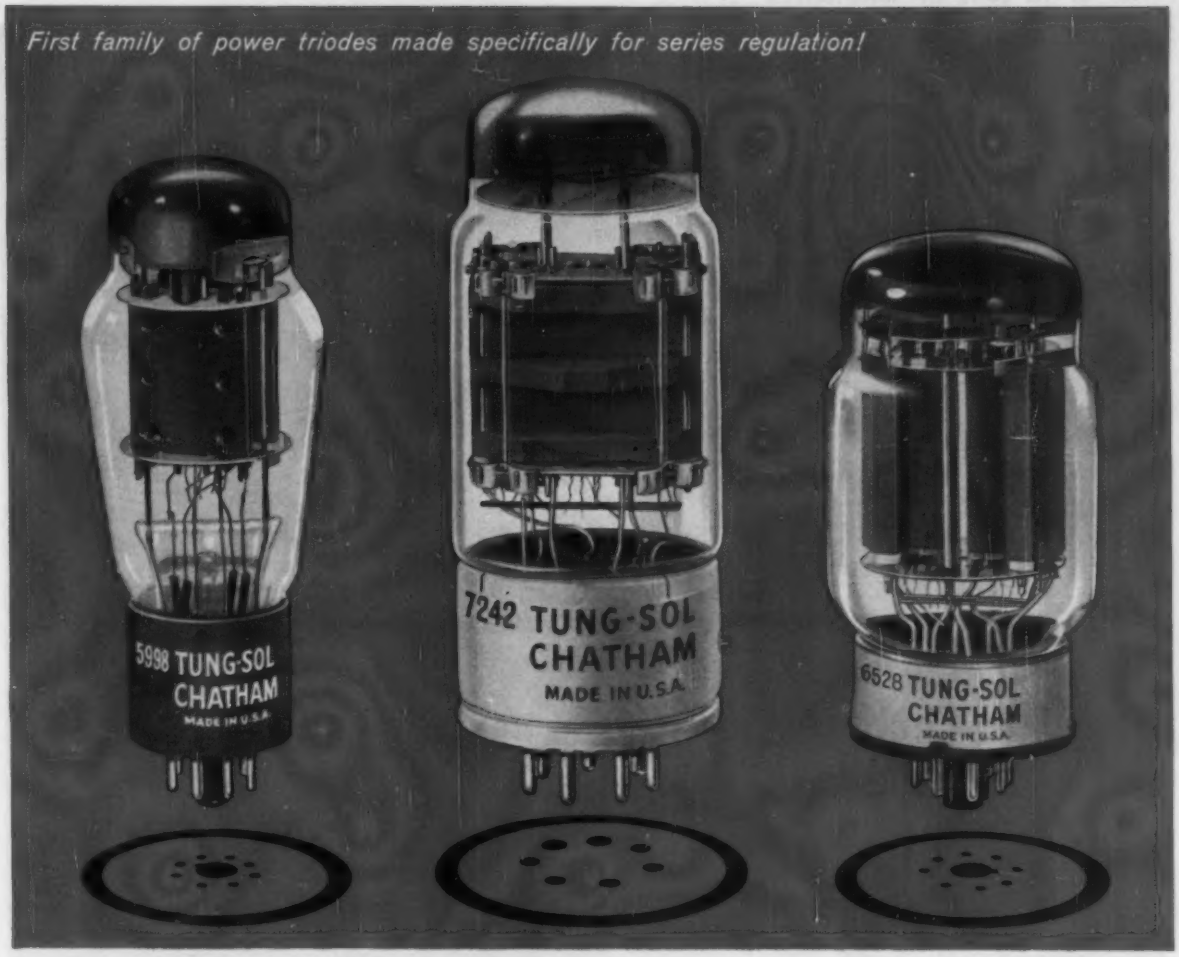
To record high frequency variables—and monitor them as they are recorded—use the Visicorder Oscillograph. Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Honeywell

Heiland Division

Reference Data: Write for Visicorder Bulletin

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division, 5200 E. Evans Ave., Denver 22, Colorado


First family of power triodes made specifically for series regulation!
5998 TUNG-SOL CHATHAM MADE IN U.S.A.
7242 TUNG-SOL CHATHAM MADE IN U.S.A.
6528 TUNG-SOL CHATHAM MADE IN U.S.A.

Tung-Sol/Chatham power triode family covers every series regulator need!

Now designers can specify a premium quality Tung-Sol/Chatham tube for all series regulator sockets. Tung-Sol/Chatham's family of power triodes — the first designed and produced specially for series regulator service — meets all design requirements and assures maximum reliability and life at all times.

Types include the new 100 Watters, 7241 and 7242, medium mu or low mu-high current. 12 or 26 Volt heater versions available on most types. All embody sturdy construction features that contribute to overall ruggedness and long hours of heavy-duty operation.

Compare the ratings below against your particular application! If you desire complete data sheets . . . or you have a specific design problem, contact us today! We'll be glad to give whatever assistance we can. Just write: Tung-Sol Electric Inc., Newark 4, N. J., Commercial Engineering Offices: Bloomfield and Livingston, N. J., Culver City, Calif., Melrose Park, Ill.

TYPICAL VALUES				
	Total Plate Current	Range of Tube Voltage Drop	Minimum Tube Drop	Grid Voltage Swing
[illegible]	200 ma	80 v	45 v	20 v
[illegible]	400	65	70	10
[illegible]	600	80	70	13

PERTINENT CHARACTERISTICS PER TUBE				
	Max. Plate Current	Max. Plate Voltage	MU	Gm
[illegible]	280	275	5.5	28,000 umhos
[illegible]	600	400	9.0	74,000 umhos
[illegible]	900	400	9.0	111,000 umhos

TUNG-SOL®

TUBE TYPES BY PLATE DISSIPATION RATINGS			
Total Plate Dissipation	26 to 30 W	60 W	100 W
[illegible]	6AS7G, 6082 6080WA, 7105	6336A 6394A	7241
[illegible]	5998	6528	7242

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Second–and this too is a "first"–we have published the first fundamental data on characteristics of bobbin cores for circuit designers. Need core total flux characteristics as related to core material? Want switching time vs drive levels? How about typical spreads of core characteristics? It's all yours.

Third–and this too is a "first"–we automatically give you test data for prototype orders. With your prototype cores come open-circuit outputs, total flux, and squareness data. You get a basic understanding of the core's characteristics under specific test conditions. More important, when you re-order production quantities, you will be able to duplicate the core around which you designed your circuit.

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MAGNETICS inc.

RELIABILITY WITH OHMITE® RELAYS

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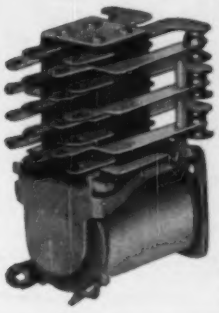
- with exclusive "Molded Module"* contact springs
- exceptional sensitivity for small size
- designed to meet aircraft, military, and industrial applications

*patent applied for

The new Models TT and TS relays are lightweight, yet rugged. Paramount among the design innovations is the revolutionary "Molded Module" contact spring construction. The "module" is a standard, single-pole, double-throw, spring combination molded into a single compact assembly. As many as six modules can be incorporated into a relay to provide a maximum six-pole, double-throw combination. With the springs rigidly held in a matrix of tough plastic, alignment of the springs is assured. More accurate alignment of all the subcombinations (modules) on the relay is possible, and adjustment of the individual contact springs is easier and more permanent. Diall Phthallate, the molding material, is capable of withstanding temperatures to 400°F.

A contributing factor to the remarkable sensitivity of these relays is the design of the armature retaining guard to minimize undesirable heel gap. A wide variety of hermetically sealed enclosures is available.

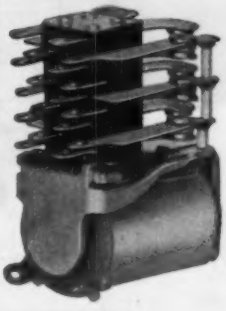
Model TT



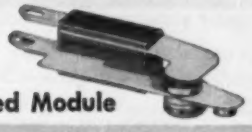
Molded Module

Coil Wattage: rated nominally at .150 watt per pole at an ambient temperature of +20°C; Coil Operating Voltage Range: to 115 vdc; Contact Ratings: up to 5 amperes at 115 volts ac or 32 volts dc noninductive, with standard contact material, palladium. Other materials can be supplied; Contact Combinations: standard combinations are dpdt, 4pdt, and 6pdt (maximum). Others can be furnished. Weight: approximately 2 ounces for 4 pdt relay.

Model TS



Coil Wattage: rated nominally at .250 watt per pole at an ambient temperature of +20°C; Coil Operating Voltage Range: to 115 vdc; Contact Ratings: up to 10 amperes at 115 volts ac or 32 volts dc noninductive with standard contact material, silver-cadmium oxide. Other materials can be supplied; Contact Combinations: standard combinations are dpdt, 4pdt, and 6pdt (maximum). Others can be furnished. Weight: approximately 3 ounces for 4pdt relay.



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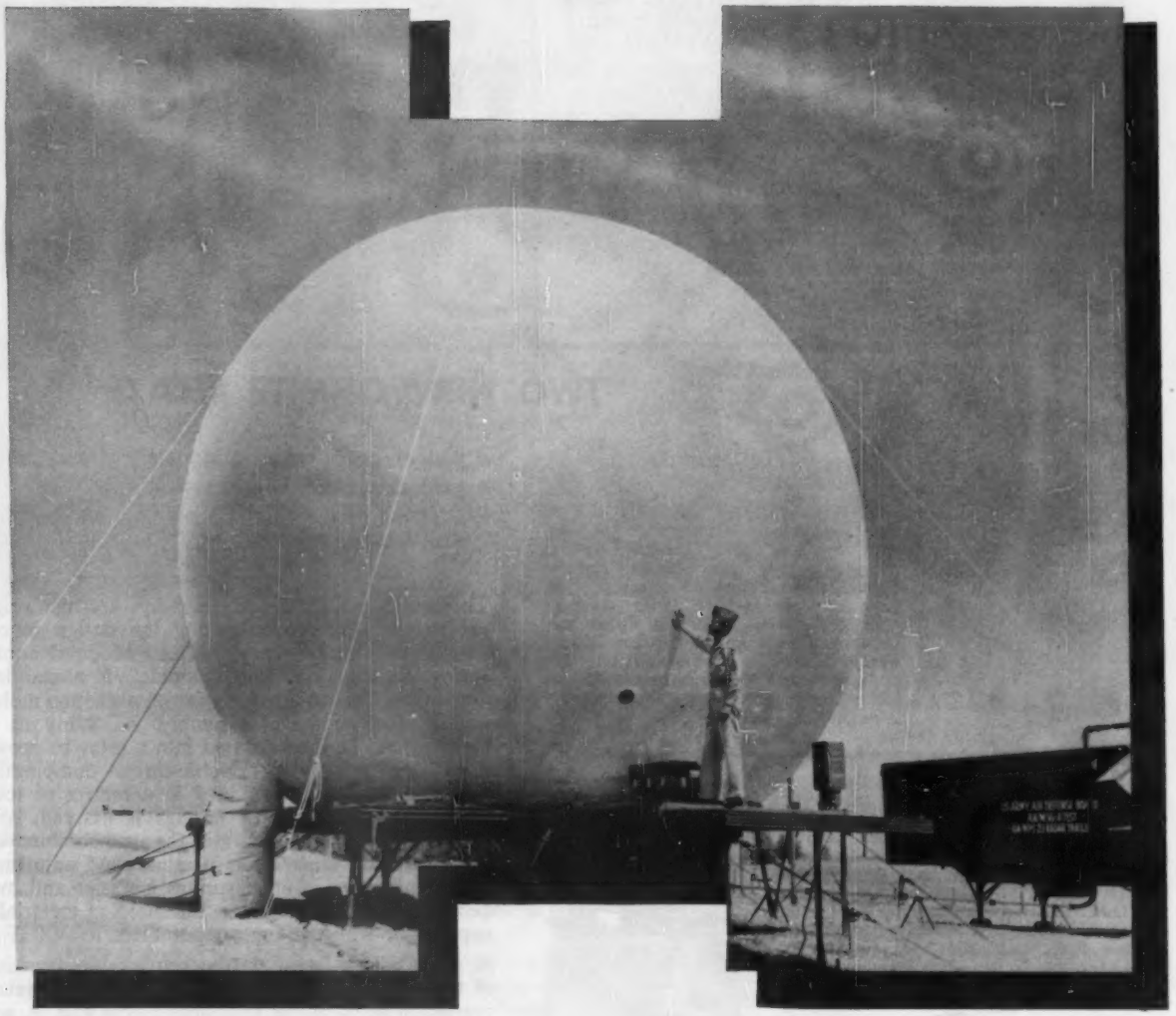
The strange shape



# of defense

This plastic balloon, resting on a mobile trailer bed like a golf ball on a tee, protects the new Hughes three-dimensional radar antenna.

Frescanar, the exclusive system combining high-speed data processors and a frequency scan radar antenna, has been developed by Hughes engineers in Fullerton, California.

Sensitive to the inadequacies of conventional radar, these Hughes Fullerton engineers have devised a radar antenna whose pointing direction is made sensitive to the frequency of the electromagnetic energy applied to the antenna. This frequency sensitivity results in the radar beam being radiated from the antenna at different angles, depending on the frequency of the energy supplied. With the supply of a succession of frequencies, the antenna beam can be moved through a succession of positions. Utilizing this advanced technique, range, bearing and altitude can be detected... on a single antenna.

This Hughes-developed radar system has been combined with compact, high-speed Hughes data processors to provide a completely self-sufficient, mobile radar defense system.

Other Hughes projects provide similarly stimulating outlets for creative engineering talents. Current areas of Research and Development include Advanced Airborne Electronics Systems, Space Vehicles, Nuclear Electronics, Subsurface Electronics, Ballistic Missiles ... and many more. Hughes Products, the commercial activity of Hughes, has assignments for imaginative engineers for research in semiconductor materials and microwave tubes.

The diversity and advanced nature of Hughes projects provides an ideal environment for the engineer or physicist interested in advancing his professional status.

An immediate need now exists for engineers in the following areas:

Microwave & Storage Tubes	Reliability Engineering
Field Engineering	Systems Analysis
Quality Control	Circuit Design
Semiconductors	Communications
Digital Computer Engineering	Radar

Write in confidence, to Mr. Phil N. Scheid,
Hughes General Offices, Bldg. 6-G-2, Culver City, California.

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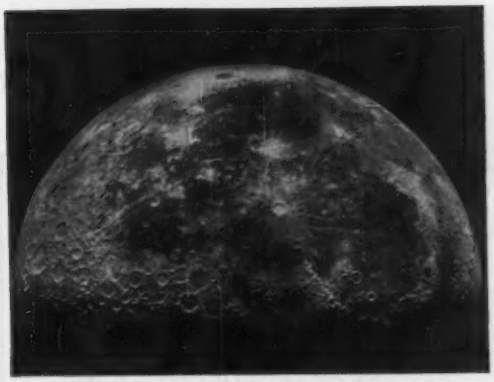
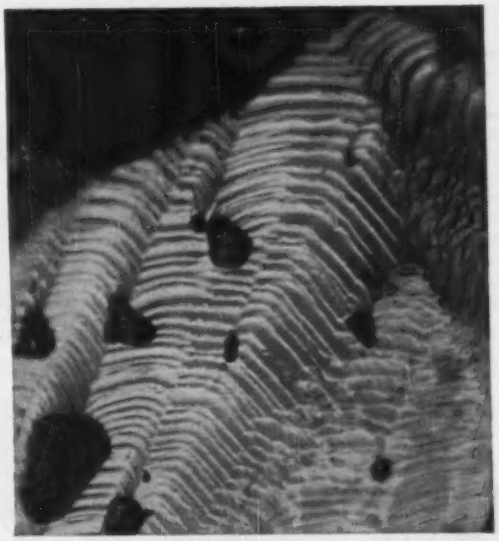


The Hughes Communications Laboratories have as one objective the development of systems capable of deflecting their signals from meteors, artificial satellites and even the moon.



This photomicrograph of an etched silicon sphere is used in basic studies of semiconductor materials at Hughes Products, the commercial activity of Hughes.

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STRIPED CONTACT SWITCHING COMPONENTS

General Plate's exclusive PT* solid phase bonding process is now being used to continuously clad one or more stripes of contact metal to any desired base metal — above the surface or flush — without contaminants introduced by bonding agents.

The result? A new STRIPE CONTACT STOCK which can be fed through automatic high speed presses for L-O-W cost production of electrical switching components.

Here are extra benefits — (1) contacts made of General Plate STRIPE CONTACT STOCK have the best possible electrical and thermal conductivity, because the metals in them are directly and permanently joined, eliminating sources of localized resistance — (2) STRIPE CONTACT STOCK goes through forming tools like a single metal, eliminating dimensional tolerances involved in assembling small separate pieces — (3) parts are ready for production as you receive them — save you time and the handling of blanking scrap, freeing extra dollars to work for you elsewhere.

With 41 years of metal bonding experience behind the emphasis now being put on improved electrical contacts and contact materials at M&C, it will pay you to investigate the General Plate line. We offer — complete technical information — engineering design assistance — samples — on-time deliveries. Our competent Field Engineers will gladly call at your request and review your contact questions without obligation. Write today.

*U.S. Patents 2,691,815 — 2,753,623

What metals can be bonded to produce STRIPE CONTACT STOCK by General Plate's PT bonding process?

Any combination of malleable metals can be permanently joined to produce STRIPED CONTACT STOCK in long length coils.

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CIRCLE 66 READERS SERVICE CARD

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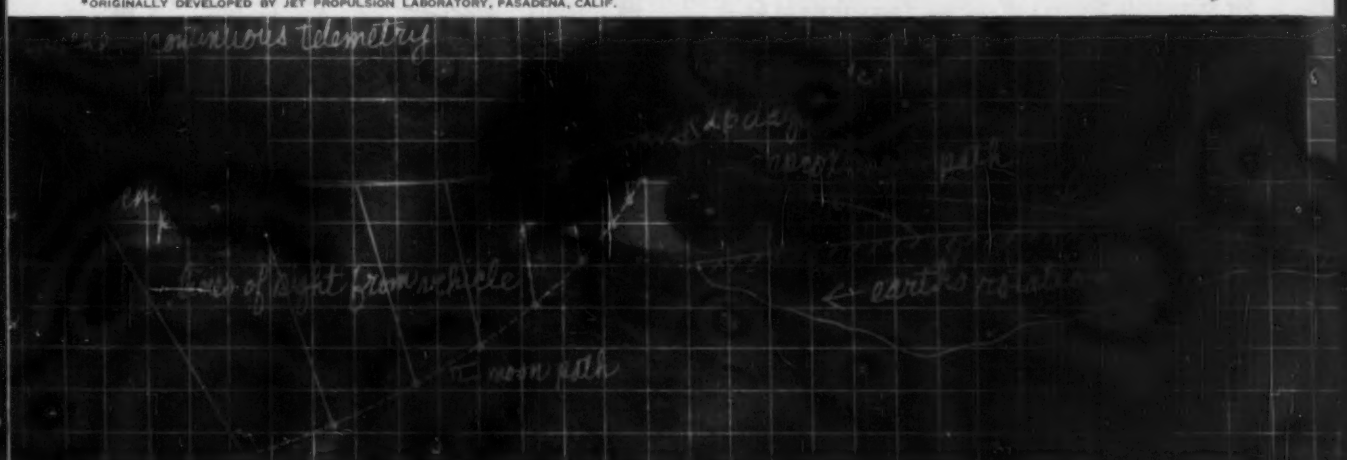

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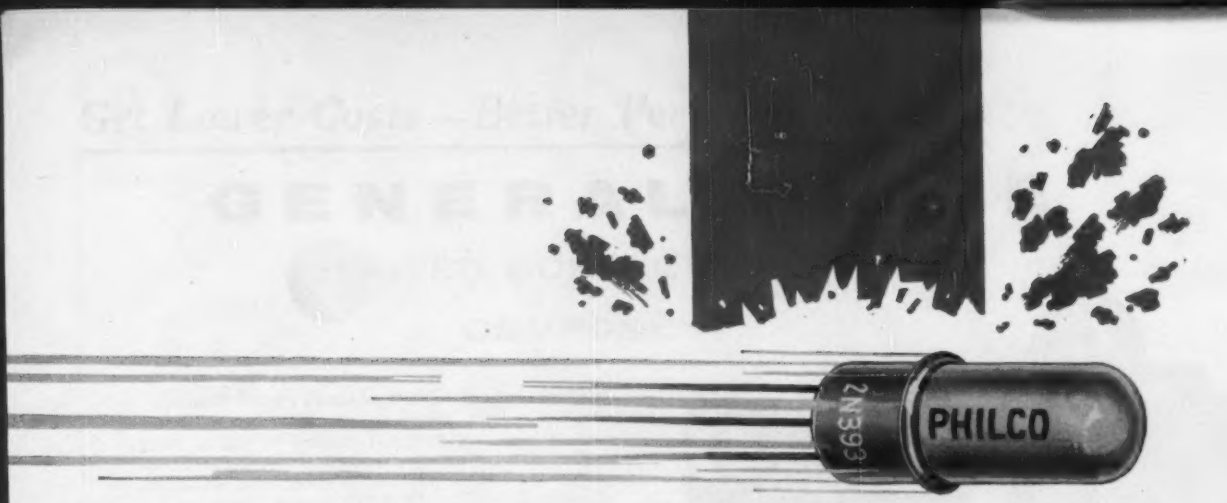

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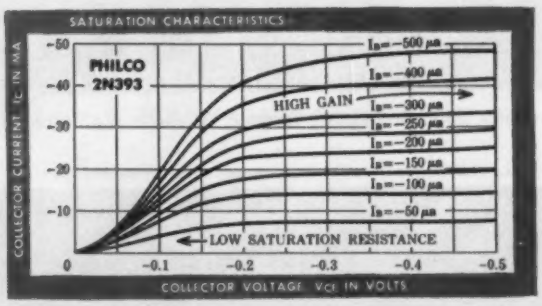

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electronics
engineering issue
DECEMBER 5, 1958

Author checks out single-chassis dual-channel stereophonic amplifier at Cherry Hill Laboratory

Stereophonic Amplifier for Home Phonographs

Dual-channel single amplifier represents one manufacturer's approach to problem of reproducing both stereophonic and monophonic signals at cost approximating that of a single-channel push-pull amplifier. Superior performance is obtained with present monophonic records since pinch distortion, which appears as vertical-motion signals, is cancelled

By **ROY S. FINE,** RCA Victor Radio & Victrola Div., Radio Corporation of America, Camden, N. J.

ADVENT of practical stereophonic disk records this spring has challenged instrument manufacturers to design equipment for reproduction of stereophonic disks that are in the same retail price class as their single-channel reproducers. Though a variety of systems have appeared on the market this goal has not yet been fully achieved.

One approach to the problem is to make available a two-channel stereophonic instrument which will play the stereophonic and conventional disks monophonically and which can be converted to stereophonic reproduction by the addition of only a second loudspeaker system.

Performance

The complete stereophonic instrument minus its second speaker may sell for only a small increase in price, which can be justified by the built-in stereophonic feature. Optimum performance from such a system will be achieved only if the second-channel loudspeaker system matches the performance of the basic stereophonic system. However, satisfactory results can be obtained with some deviation.

To meet these requirements, an

amplifier design has been developed that operates at full power capabilities at all times and is in push-pull for the monophonic reproduction of either monophonic or stereophonic sources. For stereophonic reproduction from a stereophonic source the circuit is separated into two independent single-ended feedback amplifiers.

Loudspeaker Phasing

A block diagram of two power amplifiers using two separate and independent output transformers is shown in Fig. 1A. If identical loudspeaker systems are connected to the output transformers, equal performance on each channel will be obtained when equal signals are impressed on the input terminals of amplifiers *A* and *B*. Assuming identical phasing of each system from input to loudspeakers, equal in-phase input signals will produce equal in-phase output signals from the loudspeakers. If the two voice coils are then tied together, two single-ended amplifiers in parallel are obtained, giving the power output and the same percent distortion obtained from each one separately.

If, however, the input signals are equal in amplitude and opposite in phase, as in Fig. 1B, the output signals at the loudspeakers will be out of phase. If the two voice coils are then connected in parallel, the signals will cancel and there will be no output from the speakers. By reversing the primary of one output transformer, as in Fig. 1C, the voice

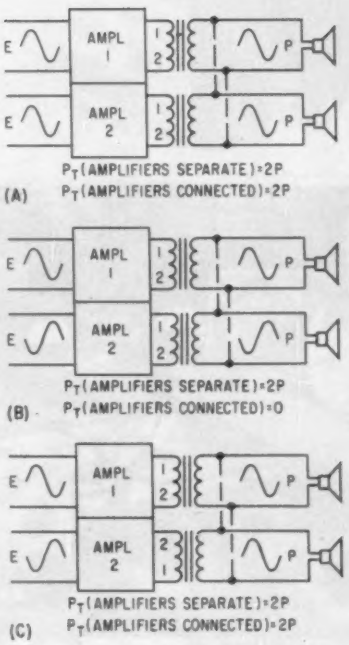


FIG. 1—Phasing combinations of amplifiers with separate output transformers

coils can again be tied together in proper phase to obtain a push-pull monophonic amplifier which reduces the even-order harmonics generated in the power output stages.

An instrument incorporating such an amplifier is satisfactory for stereophonic reproduction and is essentially the same monophonically as any push-pull amplifier when the input signals are phased as in Fig. 1C.

The Westrex system was designed so pure lateral displacement will give equal and out-of-phase signals from the left and right halves of the pickup and a pure vertical signal will give equal in-phase signals. Since composite signals recorded from a Westrex cutter can be resolved into lateral and vertical components, the signals supplied to the input terminals may be of three types: equal out-of-phase signals from lateral components, equal in-phase signals from vertical components and a single signal from one channel of a stereophonic recording with no modulation on the other. For stereophonic use, both channels operate as independent single-ended amplifiers.

Circuit

The complete amplifier shown in Fig. 2 consists of two separate channels from input to output with provision for tying the outputs together for monophonic operation. A push-pull or out-of-phase polarity of input signal is required to maintain the proper in-phase relationship at the loudspeaker. The stereophonic pickup used with this amplifier gives equal out-of-phase signals from a lateral monophonic disk as well as out-of-phase signals from lateral motion in disk made with a Westrex 45/45 cutter.

On the phonograph and tuner positions of function switch S_1, both halves of the stereophonic signal are available at the tape jack, making possible stereophonic tape recordings from records or stereo-

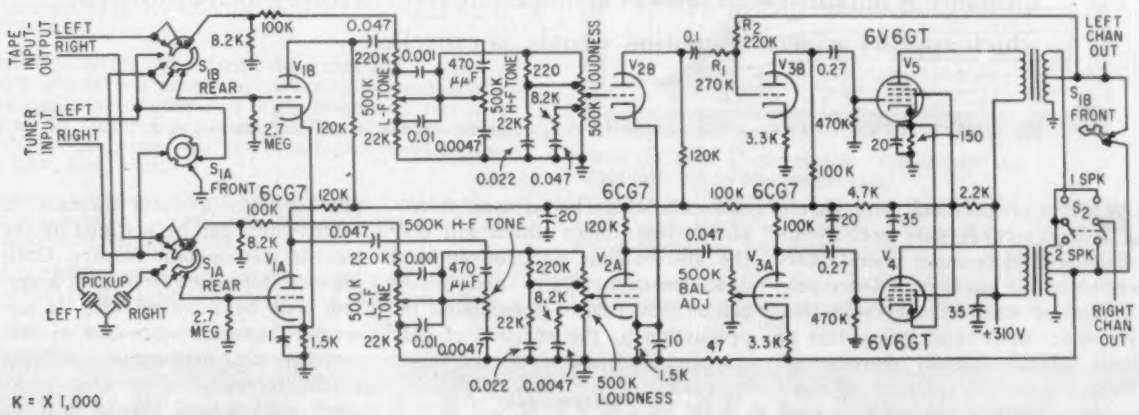


FIG. 2—Five-tube amplifier can be used as conventional push-pull amplifier or as two single-ended stereo amplifiers

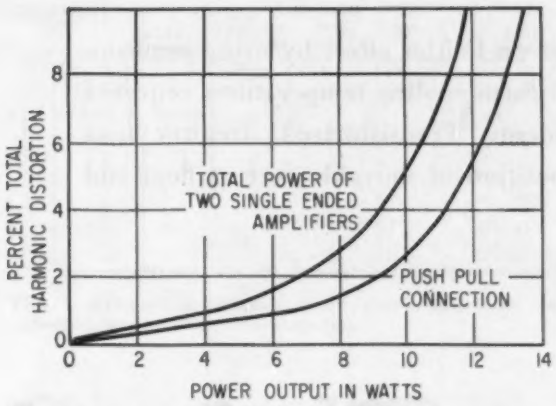


FIG. 3—Distortion for push-pull and single-ended operation

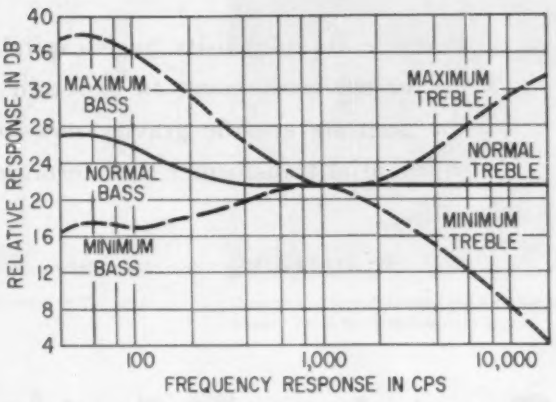


FIG. 4—Response characteristics obtainable in either channel

phonic tuner. The approximately 8,000-ohms ouput impedance is such that cable capacitances up to 1,000 $\mu\mu$f can be used with an amplitude loss at 15 kc of less than 1 db. On the tape position, this jack becomes an input for playing back stereophonic or conventional tape recordings.

Comparable Circuits

Tone and loudness control circuits are conventional except that the ganged controls require superior tracking qualities to maintain equal tone and loudness balance on both channels.

The power amplifier stages differ somewhat from the conventional because of the phase inversion at one plate and the application of negative feedback. On the right channel, the feedback voltage is taken from the 4-ohm tap of the output transformer and injected into the cathode of V_{2A}. This results in about 15 db of degeneration.

On the left channel, the feedback voltage is also taken from the 4-ohm tap, but because it is reversed in polarity with respect to the signal on the grid of V_{2B}, it is injected at this grid to effect negative feedback. Resistor R_1 isolates the relatively low source impedance of V_{2B} so the feedback is not shorted out and acts in conjunction with R_2 as a voltage divider to effect lower gain in this channel, enabling balance adjustment in the right channel.

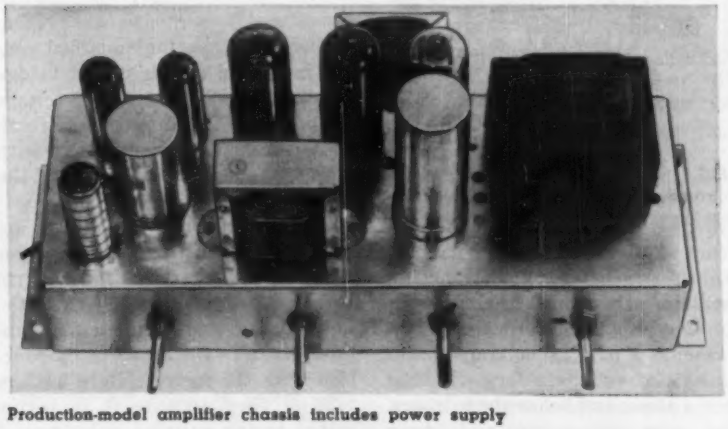
Though single-ended amplifiers are employed and the a-c ripple component of the high-voltage supply is not cancelled in a conventional push-pull output transformer, increased filtering is not required. Any ripple voltage present is injected inside the feedback loop and degenerated by the amount of the feedback. The hum at the voice coils is essentially the same as in a conventional amplifier with the same gain.

Switch Positions

When the amplifier is used for monophonic reproduction the output circuits are tied together by S_{1B} to effect push-pull operation.

Switch S_2 in its 2-SPEAKER position matches the output transformers to the proper load (4 ohms) and allows the single-ended or push-pull condition to be selected by S_{1B}. When S_2 is in the 1-SPEAKER position and no external speaker is connected to the left-channel output, both amplifiers are properly matched to the single internal speaker system and the amplifier is always in the push-pull condition regardless of the setting of S_{1B}. This situation is required when the instrument is to be used as a conventional radio-phonograph and full power output is desired.

The amplifier distortion is shown in Fig. 3. The distortion is lower for push-pull operation, even with twice the power output of a single channel, confirming that even-order harmonics are reduced. For example, for 12-w total output on two single-ended channels the distortion is 10 percent, but for 12-w output in push pull it is only 5.5 percent. Figure 4 shows the frequency response.



Production-model amplifier chassis includes power supply

Portable liquid-density gage capitalizes on Peltier effect by using semiconductor thermoelements to maintain uniform cooling temperatures required for accurate specific gravity measurements. Transistorized circuitry uses differential transformer to determine position of movable core at float end

By C. W. HARGENS, Senior Staff Engineer, The Franklin Institute Laboratories, Philadelphia, Penn.

Semiconductors Cool and

ACCURATE MEASUREMENTS of liquid densities usually require delicate balance mechanisms or large hydrometers that use complex plumbing to maintain a constant cooling temperature. These intricacies are eliminated, and precise liquid-density measurements are simplified with this sturdy, highly practical, transistorized gage.

Figure 1 shows a cross section of the unit. As the bottom fan circulates cooling air, a small magnet in the liquid sample stirs the test solution. The flow of current through thermoelements, controlled by a thermostat, keeps the liquid at constant temperature.

The core, rigidly attached to a rod moves through a differential transformer and the buoyant force of the float is measured by a balance coil suspended in a permanent-magnet field. At balance, the coil and float always return to null position, which is determined to a tolerance of approximately 10 microinches. Output of the differential transformer reverses phase at center, providing a sensitive, accurate means of determining a reference position.

Fluctuations in output amplitude and changes in amplifier gain or power-supply voltage do not affect zero.

The balance coil current is adjusted by first observing a zero-center meter which registers approach to null. The balance current, which is supplied by a steady d-c source, is controlled by a physically long slide wire capable of high resolution. This slide wire is compactly constructed by shuttling the resistance element between two spools. A calibration strip, attached to the edge of the resistance element and visible through a window, is used for nonlinear calibrations. The d-c source is Zener stabilized.

Transistor Circuitry

In the null-position detecting circuit of Fig. 2, a 5-kc sinusoidal current is generated by a transistor oscillator in which the primary winding of the differential transformer is a part. The transformer consists of two secondary windings placed above and below the primary. The core moves up and down through their centers and, when it is in precisely mid-position, distributes flux so that equal amounts link the two secondaries. If these windings are connected in series, with correct polarity, their voltages cancel.

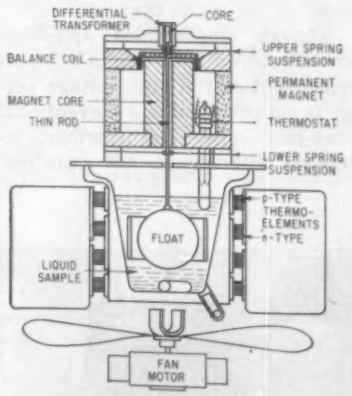


FIG. 1—Cross section of liquid-density instrument shows mechanical components and thermoelectric cooler

As the core passes from one side of null to the other, a phase shift of 180 degrees occurs in the output sum of the secondaries. Near balance, this small voltage is amplified. Three transistor stages follow, which saturate when handling the large range of signal voltage from the differential transformer. The null signal is amplified until its magnitude is approximately equal to the oscillator voltage impressed upon the primary. These two voltages are then applied to a phase-comparison circuit.

Phase Comparison

The phase-comparison circuit consists of four diodes arranged in a bridge. When the amplified voltage is applied to one pair of bridge terminals, and the oscillator voltage is applied to the other pair, a rectified current which reverses with phase change will flow in one of the branches.

This direct current could be applied directly to a zero-center meter to indicate balance. However, to increase overall sensitivity of the indicating system, a single d-c amplifier stage is employed in conjunction with the meter. Here an *npn* type is used because it is better suited to the existing polarities.

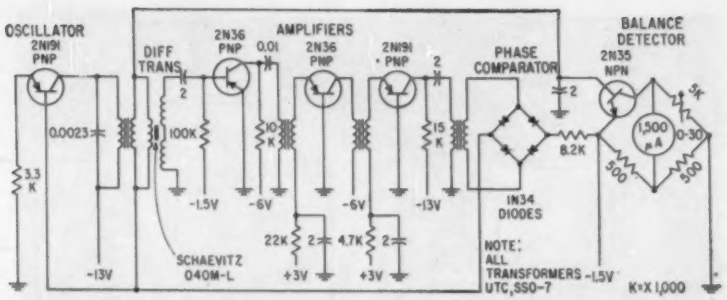


FIG. 2—Null-position detecting circuit shows differential transformer with core between primary and secondary windings

Operator of liquid-density gage removes density head to introduce test liquid

Control Density Gage

Accurate density measurements are usually carried out at 60 F, partly because there is less likelyhood of bubble formation that would occur at higher temperatures. Bubbles are a source of error in buoyancy measurements.

Thermoelectric Cooling

The thermoelectric cooling principle eliminates the need of a compressor and the complexities of a conventional mechanical refrigerator.

The cooling method used is a highly significant application of the familiar Peltier effect, known for over 100 years. The Peltier effect applies to a simple circuit of two dissimilar metals connected in series. Heat is transferred by an electric current from one bond, a cold junction, to another bond, a hot junction. Once a novelty, application of this effect is made possible by a knowledge of semiconductor technology.

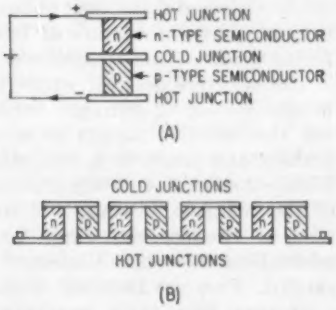


FIG. 3—A single junction of the thermoelements (A) consists of two dissimilar semiconductors joined by copper connector. A group of junctions is arranged as shown in (B)

Efficiency is still low, but freezing temperatures are obtained in minutes and advantages of convience and simplicity prove the method highly practical.

About 40 watts are consumed in the thermoelectric cooler. The thermoelements are shown in Fig. 1 at the sides of the liquid container. Forty of these elements, connected in series, carry about 10 amps. A single junction consists of two dissimilar semiconductors joined by a copper connector (Fig. 3A). A group of junctions is arranged (Fig. 3B) by alternating *p* and *n* type thermoelements which are joined by copper links.

The thermoelements, made of bismuth telluride, are doped to produce *p* and *n* type semiconductors and are soldered to the copper links with care. When so grouped, the elements are electrically insulated from the aluminum container with thin Mylar. Copper cooling fins dissipate heat from the hot junctions.

Temperature Uniformity

A small cylindrical magnet, protected from the liquid by a Teflon coating, is caused to spin in the bottom of the cup by a second magnet attached to the center of the fan.

Stirring keeps the liquid at a uniform temperature throughout and also insures maximum heat transfer by the cooler. A drain removes the 100 cc of liquid.

Accurate temperature control is achieved by a glass thermostat immersed in the liquid. If the current is reversed, a cold junction becomes a hot junction. A current reversing relay, connected to the thermostat, can produce both hot and cold as may be called for to establish controlled temperature.

Applications

Makers of petroleum products, chemical reagents, foods and liquified gases see great advantages in this gage.

Proof of whiskey, which is a volume concept rather than a common density measurement, is readable directly with the long-scale, nonlinearily calibrated slide wire.

Tax on whiskey is levied upon its proof, hence high accuracy in such determinations is required. Proof must be read to 0.1 percent or 0.0001 over the 0.8000 to 1.0000 density range from pure alcohol to pure water.

Thanks are due the Whirpool Corporation Research Laboratories at St. Joseph, Michigan who provided the thermoelectric cooling unit for this application. George A. Smith of Busser, Smith and Harding of Philadelphia worked out the principle of the device with the author. J. C. Heselwood designed the balance coil and magnetic parts. Louis Forman sponsored the development of the instrument.

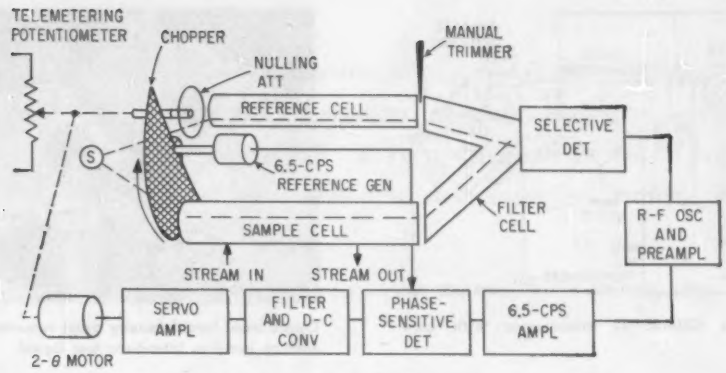


FIG. 1—Block diagram of nondispersion infrared analyzer

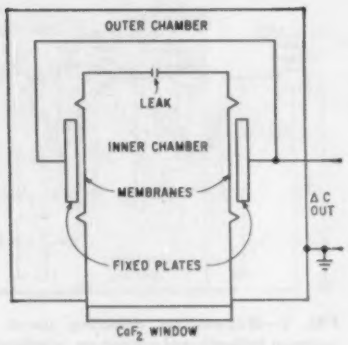


FIG. 2—View of the selective detector shows two capacitance microphone assemblies

By PAUL G. BALKO, Infrared Product Specialist, The Perkin-Elmer Corp., Norwalk, Conn.

Infrared Finds Auto

Leaks in automobile air-suspension systems as small as 8×10^{-5} cubic inch per second can be detected in three seconds. Nitrous oxide replaces air for test purposes. A nondispersion infrared analyzer is the sensitive instrument used for production testing

AUTOMOBILE air-suspension systems must be production tested to insure leak-free operation. One test setup now in use takes advantage of the capabilities of infrared detection. The suspension system is pressurized with nitrous oxide, an infrared active tracer gas. A nondispersion-type infrared analyzer is the test instrument.

The nondispersion analyzer has found its greatest use as a monitor for hydrocarbon streams where one component is the key to some reaction. Wavelength selectivity and discrimination are obtained by use of a selective detector, gas filtering (by the interfering component) and a combination of window materials that possess different transmission characteristics in infrared.

Basic Analyzer Elements

Figure 1 shows the basic components of the system. The radiation source *S* consists of a nichrome wire helix coated with iron oxide. An input of 10 v a-c at 3.2 amp provides a temperature of 650 C.

A diverging cell splits up the radiation energy into two paths—the sample beam and the reference beam. With the radiation source and two windows, the cell makes a vacuum-tight assembly. It is filled and sealed off with one atmosphere of N_2, a noninfrared-absorbing gas.

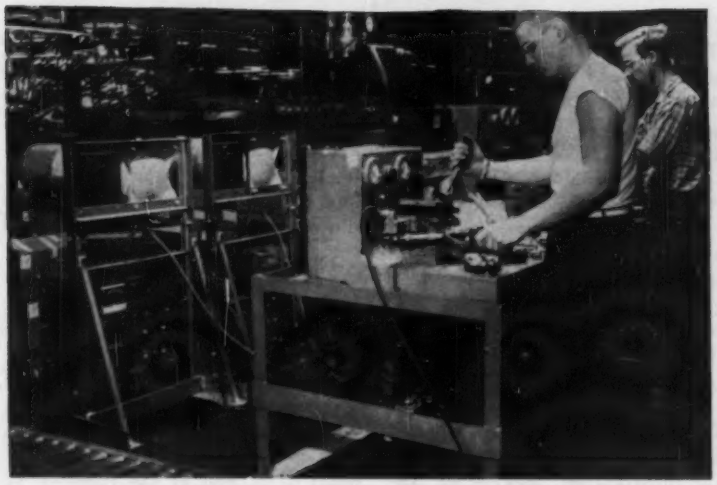
Chopper System

The radiation chopper system consists of a 1,200-rpm synchronous-drive motor, a drive belt, a chopper disk with a 180-deg circumference and a two-pole reference generator. Pulley ratios give the chopper a speed of 6.5 cps and the beams are chopped 180 deg out of phase. The generator is driven directly from the chopper shaft to provide a 6.5-cps reference signal.

The sample cell is 11-in. long, has a removable window at each end and the necessary fittings to accommodate the sample stream line. The reference-cell assembly is identical except that it has a fixed window at either end. This cell is vacuum-tight and sealed off with one atmosphere of N_2. The nulling attenuator is located in this beam.

The filter cell provides two functions. It converges the radiation beam and, since it is in series with the sample beam, provides a method of spectral or gas filtering. It is vacuum-tight and usually sealed off with a mixture of interfering gases at one atmosphere.

The selective detector employs a unique system of dynamic balancing that reduces signals from vibration and shock to a minimum. Figure 2 shows a cutaway top view of the complete assembly. It consists of two separate capacitance microphone assembles connected in parallel. They are installed in such a manner that their membranes divide the assembly into two chambers. A small pneumatic leak, 0.01 in. in diameter, connects the two



Leak detectors (left) check component parts of auto air-suspension systems both before and after final assembly

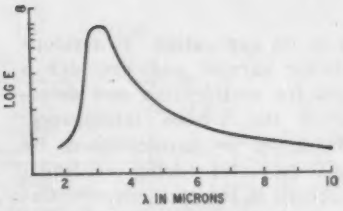


FIG. 3—Black body radiation curve at 650 C shows why the selective detector is limited to duty between two and seven microns

Suspension Leaks

chambers. The membranes are 0.00025-in.-thick aluminum foil with a diameter of about one inch. Each microphone has 100-$\mu\mu$f capacitance.

The assembly is evacuated and filled with an infrared active gas to about 250 mm Hg absolute pressure. This gas is the same one for which sensitivity is required—nitrous oxide in the application under discussion. If infrared radiation, chopped at a frequency of 6.5 cps, enters the inner chamber through a selected window material, the gas will be heated and cooled alternately. Resulting pressure changes will flex the membranes.

The capacitance change that occurs will be the sum of the capacitance changes in the two microphones. Of significance is the fact that the radiation flux contains the necessary frequencies to excite the gas molecules in the detector.

The pneumatic leak is a high impedance at 6.5 cps but provides equilibrium between the two chambers during slow ambient temperature changes.

Detector Operation

If a force or shock is imparted to the microphone from left or right, the net change in capacitance will be zero. Each membrane, because of its light mass, tends to remain stationary as the heavier assembly follows the force. Vibration signals are attenuated 20 times over a single microphone.

The radiation-energy curve shown in Fig. 3 limits the selective detector to duty between two and seven microns. Signal output from the detector is proportional to the chopping period. Strong absorbers of infrared radiation produce a large change in capacitance. The microphones form part of the grid tank circuit of a tuned-plate tuned-grid r-f oscillator. It is through this circuitry that electrical translation is accomplished and signals can be measured and interpreted.

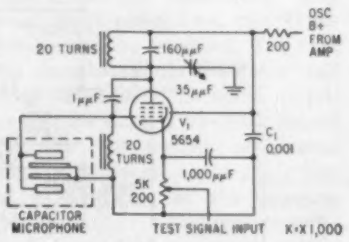


FIG. 4—Circuit for the r-f oscillator, preamplifier used in analyzer

Initially, both radiation paths are balanced. Since the radiation flux is 180 deg out of phase, the change in radiation at the detector will be zero and no signal will develop. When the intensity of the sample-beam radiation becomes different from that in the reference beam, the chopped radiation produces pressure changes in the detector. The membranes move accordingly and produce an error signal proportional to the difference.

The error signal is detected in the proper phase and amplified sufficiently by the electronic system to drive a two-phase servo motor. The motor, in turn, drives an optical attenuator into (or out of) the beam and restores radiation balance. Simultaneously, the motor changes the resistance of a potentiometer. This change in resistance is measured by a recorder or indicator.

Electronic Circuits

The r-f oscillator-preamplifier consists of a pentode, V_1 in Fig. 4, and its associated circuitry. As mentioned previously, the oscillator is a tuned-plate, tuned-grid type using the microphone assemblies as part of the grid-tank circuit. The stage develops a gain of about three.

The oscillator circuit is unusual

only in its application. It develops a six-mc carrier and provides a means for rectification and detection of the 6.5-cps intelligence. Rectification is accomplished by class-C operation during oscillation and occurs in the plate circuit. Capacitor C_1 filters the carrier but allows the 6.5-cps modulation to develop across R_1 in Fig. 5.

Since the carrier is frequency-modulated, a simple expedient for amplitude demodulation is accomplished by detuning the plate tank circuit off resonance and operating the circuit slightly reactive. This practice is known generally as side-slope detection.

The 6.5-cps amplifier shown in Fig. 5 consists of three stages of conventional band-passed triodes V_{2A}, V_{2B} and V_{3A}. It peaks at about 6.5 cps with 18-db attenuation at each octave. A double-T rejection filter is installed between V_{2A} and V_{2B} to attenuate any 60-cps pickup that originates in the preceding stages. Over-all gain is about 80 db and a phase inverter, V_{2B}, provides a signal that is 180 deg out of phase to the phase detector.

Detector and Filter

To provide the servo motor and indicator circuit with the proper beam information (degree of unbalance that may exist in either beam), a full-wave phase-sensitive bridge rectifier is used. The rectifier uses a reference signal developed by a 6.5-cps generator connected to the radiation chopper shaft for phase reference. Two dual diodes, V_7 and V_8, and associated circuitry are mounted on the 6.5-cps deck with two balancing potentiometers, R_2 and R_3. Potentiometer R_2 balances the diodes; R_3 balances the reference generator voltage.

At beam balance, no error signal is present. Each alteration of the voltage from the reference generator is clamped between the midpoint of R_3 and at the junction of

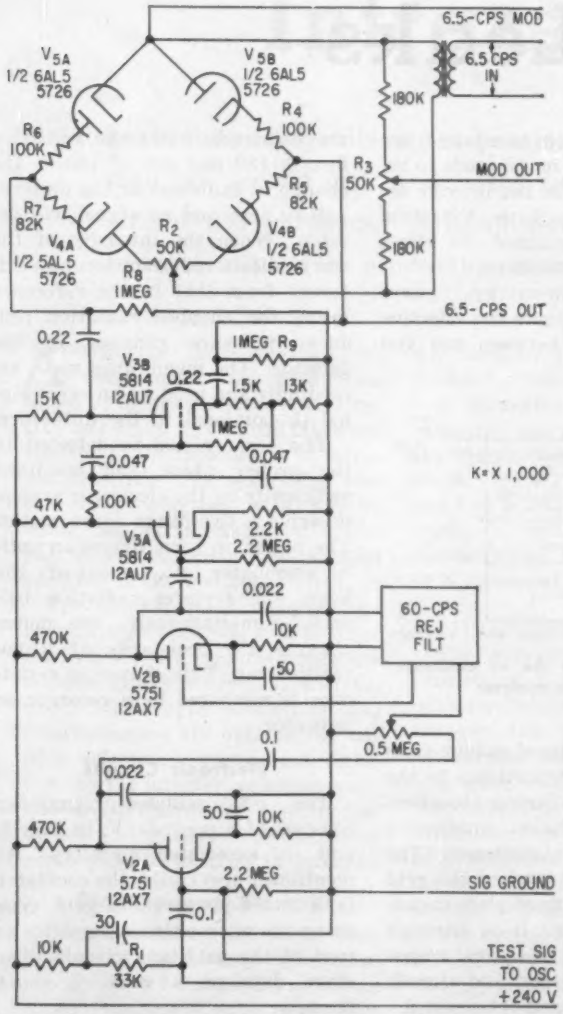


FIG. 5—Schematic of the 6.5-cps amplifier

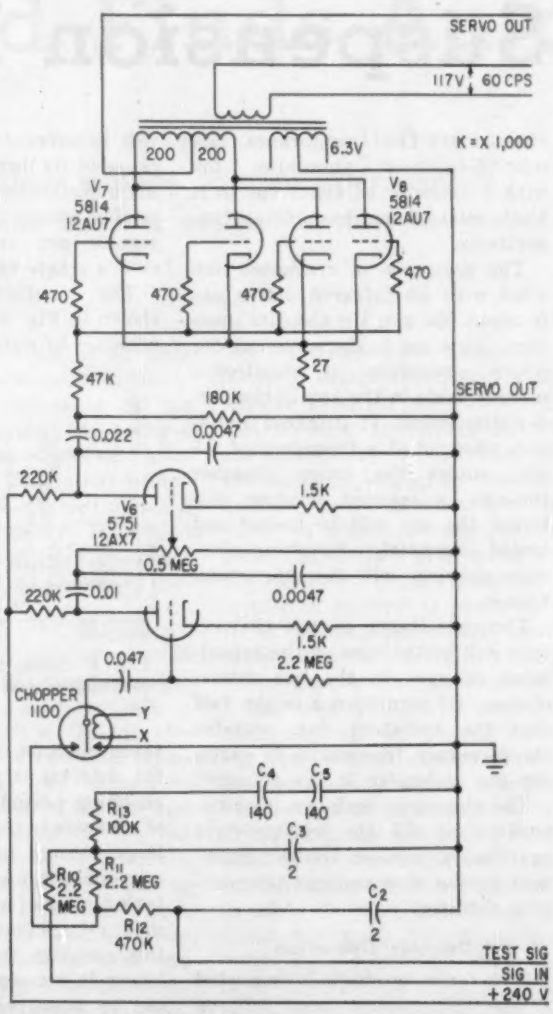


FIG. 6—Servo-amplifier schematic

R_{14}, R_5 and R_{16}, R_{17}. Consequently, no voltage appears across the output.

Assume next a condition where an error signal is developed while V_{5B} and V_{6B} are conducting and V_{6A} and V_{6A} are open-circuited. The error signal will develop across the load resistors R_5 and R_{17}. Voltage across R_{17} is proportional to the positive half-cycle across the output.

When the generator reverses polarity, V_{6A} and V_{6A} conduct and V_{6B} and V_{6B} open-circuit. The voltage drop across R_5 now appears at the output in the same polarity and full-wave rectification is completed. If the error signal information is reversed (reversal of beam energy), full-wave rectification appears at the output in the negative direction.

Thus the rectified error signal is filtered by the R-C circuitry located on the servo-amplifier deck. This circuitry consists of R_{10}, R_{11}, R_{12}, R_{13}, C_2, C_3, C_4 and C_5 in Fig. 6. Capacitors C_4 and C_5 provide filtering for both phases of rectification. Capacitors C_2 and C_3 give stability.

Servo Amplifier

The radiation chopping rate precludes use of normal component sizes to close a servo-operated loop. Consequently, the 60-cps system operates as described.

The servo-amplifier, Fig. 6, consists of a 60-cps d-c chopper, two stages of 60-cps voltage amplification V_6 and a power output stage V_7 and V_8. The output stage drives the control winding of the two-phase servo motor located on the optical bench. The reference winding uses 110-v, 60-cps line current.

The servo amplifier is band-passed at 60 cps and the overall power gain is about 80 db. Overall attenuation at each octave is about 18 db. The output stage operates class-A and provides about four watts of driving power to the motor.

The d-c error signal from the output of the filter appears at the chopper where it is chopped in either phase depending on polarity into a 60-cps square wave. It is amplified by the first voltage amplifier sufficiently to saturate the second stage and provide a constant signal to the grids of the output stage. This action is necessary to provide a constant driving speed to the motor. About 200 mv peak-to-peak is required to saturate the amplifier.

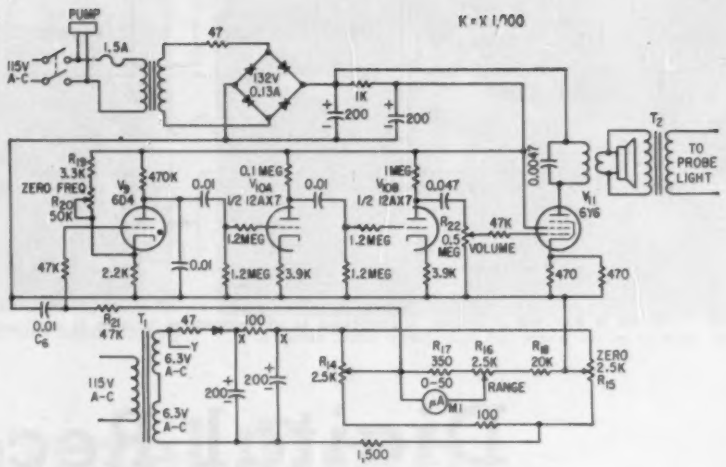


FIG. 7—Circuit for the indicator unit

Indicators

To utilize the instrument fully under plant conditions, two types of indicator are provided. The first is a variable audio oscillator and meter indicator. The audio amplifier can produce a variable signal over the full nulling attenuator range of 300 deg. About 2.5-w output is available at the speaker. Threshold of oscillation (audio zero) is variable over the entire range.

In Fig. 7, the telemetering potentiometer R_{14} and zero control R_{15} form the two branches of a bridge circuit. The meter M_1 is in the error branch. A low-voltage supply made up of T_1 and associated components supply the bridge with about 12-v d-c.

Potentiometer R_{16} provides the sensitivity or range control for the meter. Its resistance range of 2,500 ohms in conjunction with R_{17} and R_{18} will produce a change of current from 50 to 150 μa through the meter. With the wiper arm of R_{16} fully clockwise, the meter is at a 3:1 ratio with R_{14}. With the wiper arm fully counterclockwise, R_{14} is at a 1:1 ratio with the meter. Potentiometer R_{15} has no interaction with R_{16}.

Audible Indication

Tube V_9 is a thyratron whose firing rate is controlled by the position of R_{14}. Resistor R_{19} and potentiometer R_{20} (zero frequency control) are strapped across the plate and cathode of V_9 so that the conduction or firing level can be set independently of the position of R_{14}.

The sawtooth waveform produced by V_9 is handled conventionally through two stages of audio amplification, V_{10A} and V_{10B}, and a power-amplifier stage, V_{11}, to drive a six-in. speaker.

No special effort is made to clean up the waveform other than to remove the peak transient with R_{21} and C_6. Potentiometer R_{22} is the volume control. A step-up transformer, T_2, is connected across the speaker terminals and energizes a NE51 neon light to attract attention when the operator is in a noisy area or out of visual range of the meter.

An alternate system consists of a contact-carrying meter coil and set pointer that energizes a relay to operate at some scale level. The relay then energizes a horn or light.

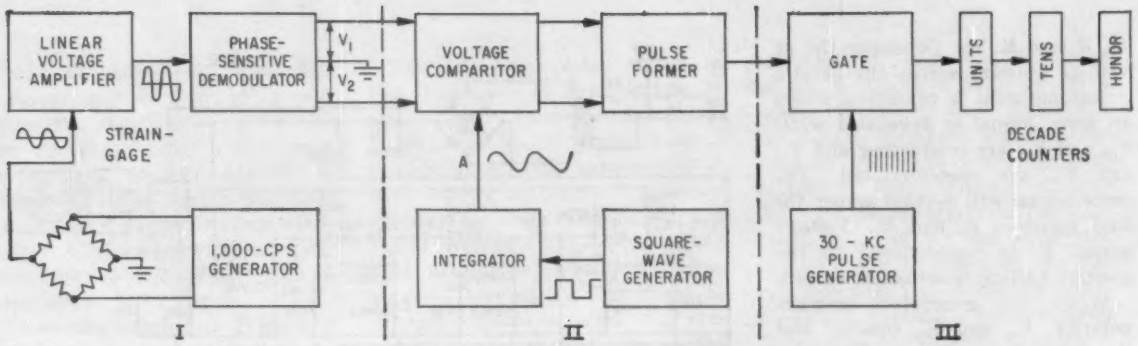


FIG. 1—Stress is detected in section I, converted to an interval of time in II and indicated in digital form in III

Digital Recorder for

Force and pressure data from wind-tunnel models are read out on punched cards and printed forms to three-digit accuracy while tunnel tests are in progress. Basic system sections may be adapted for digital recording of voltages, currents and resistances as well as recording of frequency and time-coded data

By **ROBERT C. MACARTHUR,** Principal Physicist,
and **WILLIAM J. UNGAR,** Associate Engineer, Cornell Aeronautical Laboratory, Inc., Buffalo, New York

MANUAL METHODS of digitizing, displaying and recording force and pressure data from wind-tunnel models have inherent human errors and wear problems associated with mechanical parts.

To eliminate these shortcomings, equipment has been designed wherein air loads on wind tunnel models are recorded as three decimal digits on punched cards for use with a digital computer. This technique provides final data while a tunnel test is in progress.

The new equipment meets the same requirements of the manual equipment in ignoring dynamic forces that are often greater than the desired static component and of being free of thermal and stray pickup errors.

In general operation of the equipment, four strain gages are attached, according to conventional practice, to a steel beam and then connected electrically to an automatic recorder. The recorder is then aligned according to a fixed procedure for measurement and needs no further adjustment thereafter. A count is displayed approximately every half second on the decade counters. When an IBM tabulator and summary punch are attached, the count corresponding to any particular stress on the strain-gage beam may be recorded by pressing a button.

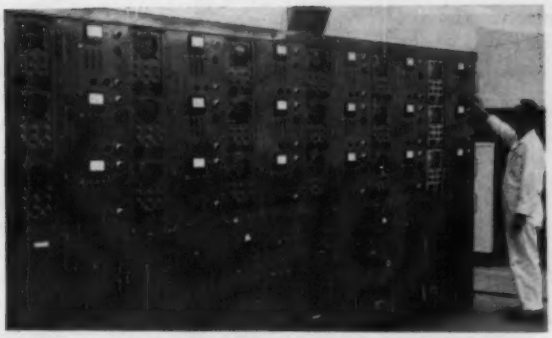
Operating Principles

Figure 1 is a simplified block diagram of the method of accomplishing the above objectives.

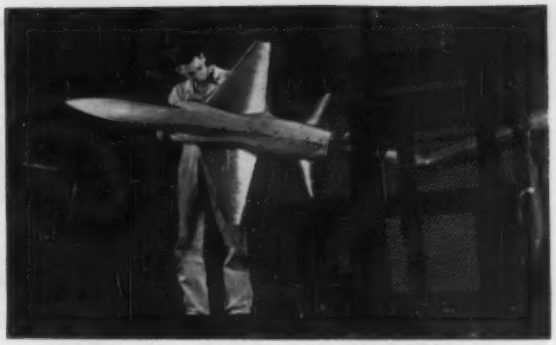
The force or pressure unbalancing the strain-gage bridge in section I causes a small signal voltage directly proportional to the stress to appear across the linear amplifier's input. This voltage is amplified and changed to d-c voltages v_1 and v_2 in the phase-sensitive demodulator.

The output of the square-wave generator in section II is integrated to form the wave pattern shown at point *A;* the negative-going ramp, linear to 0.01 percent over the section used, is compared with v_1 and v_2. The time difference between the two pulses is directly proportional to the voltage difference of v_1 and v_2 and, therefore, also directly proportional to the stress.

The two pulses derived in section 2 open a gate circuit for a length of time equal to the time difference between the two pulses. While the gate is open, pulses from a 30-kc pulse source pass through the gate circuit and are visibly totalized on three decade counters connected in cascade. Since the pulse frequency is fixed and the length of time the



Eighteen digital-recording channels are available simultaneously



Transducers being installed in test model set up in wind tunnel

Wind-Tunnel Data

gate is open is directly proportional to the stress, the digital total indicated on the decade counters is directly proportional to the stress.

Method of Operation

The instrument is arranged so that v_1 and v_2 of the phase-sensitive demodulator are always equal and approximately 70 v in amplitude at zero count. At a stress corresponding to a count of 1,000, v_1 and v_2 will have a differential of approximately 10 v; one of them being approximately 65 v, the other 75 v.

Of the waveforms in Fig. 2, *A* is representative of the pattern obtained from the square-wave generator while *B*, *C* and *D* show the integrated wave with approximate voltages and times indicated to correspond to counts of zero, 200 and 1,000. At *B*, v_1 and v_2 are equal and the resulting time interval Δt is zero since the pulses corresponding to v_1 and v_2 occur at the same time. At *C* and *D*, v_1 is greater in amplitude than v_2 and the time interval has a definite value.

The voltage values of v_1 and v_2 shown in Fig. 2 are indicative of the range possible when stressing the strain-gage beam in one direction (positive sense). However, if the beam is stressed in the opposite direction (negative sense) v_1 and v_2 will interchange positions on the diagrams. This means that while v_1 and v_2 are both equal at zero, v_1 will now be lower in value than v_2 for any count greater than zero. Similarly, as on the diagram, counts of 200 and 1,000 will be obtained.

Since it is desirable when measuring stress to know the direction of application and not merely the magnitude, a circuit indicating the time position of the pulse corresponding to v_1 and v_2 is incorporated in the equipment.

Sign Indicator

Figure 3 is an expansion of Fig. 1, including the sign indicator. A

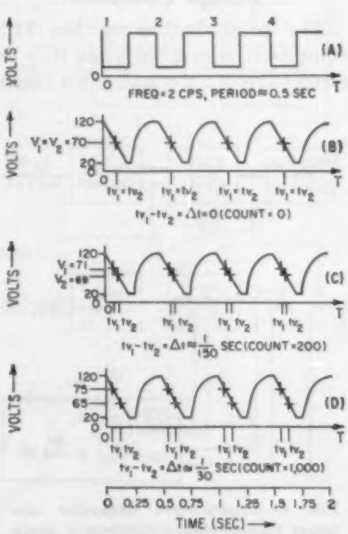


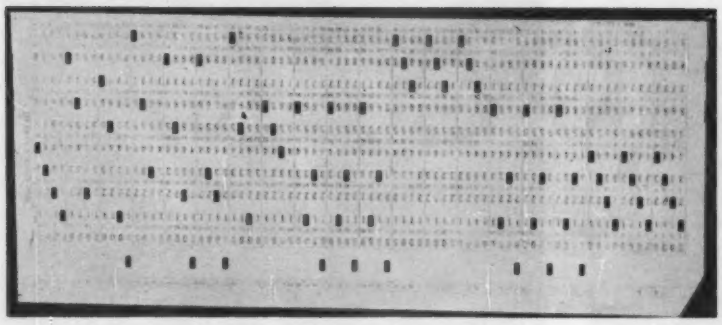
FIG. 2—Operating waveforms

negative pulse, *A*, occurring at the time the ramp voltage equals v_2 triggers a one-shot multivibrator, producing a pulse of approximately 0.3-sec duration whose leading edge occurs at the same time as pulse *A*. This pulse and another one, *B*, occurring at the time the ramp voltage equals v_1 are fed into a coincidence circuit. If pulse *B* occurs at the same time as pulse *A* or lags *A* by less than 0.3 sec, a positive pulse from the coincidence circuit fires a thyratron, pulling in a relay and lighting a bulb on the front panel of the instrument. If pulse *B* leads *A* in time, a pulse is not emitted from the coincidence circuit and the thyratron does not fire.

Maintaining Zero

When v_1 and v_2 are equal the resulting time interval is zero; however, a single pulse will be formed at the time corresponding to this voltage. This pulse *C* causes the count-gate trigger to open the gate. Since there is no second pulse, the gate would remain open and a large count would be displayed on the counters. To avoid this situation, a second pulse *D* occuring at the same time is fed into the count-gate trigger to nullify pulse *C*. The count-gate trigger then remains in its normal condition, leaving the gate closed.

Pulse *D* is formed by the count-at-zero-coincidence circuit at a



Typical punch-card read out obtained from wind-tunnel tests

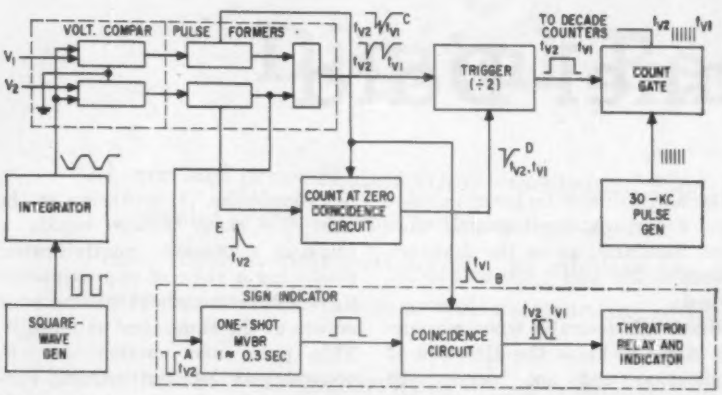


FIG. 3—Expanded version of sections II and III of Fig. 1 shows sign indicator

count of zero and at no other time since only then do the two pulses *B* and *E* fed into the coincidence circuit occur at the same time.

Referring to curves *A* and *C* in Fig. 2, time interval Δt corresponding to any given count is repeated approximately every half second. This means that every half second a bundle of pulses for any given count will be delivered to the decade counters for totalizing.

If the counters do not read zero before the first pulse of any particular bundle arrives, the counters will add the ensuing pulses to the previous count.

Counter Reset

A counters-reset circuit resets the counters to zero. This circuit consists of a thyratron which is fired at times 1, 2, 3, 4, etc. on curve *A*.

The count-gate-trigger-reset circuit is used as a precautionary measure to insure that the count-gate trigger is in its normal condition before the count interval occurs. It consists of a cathode follower which feeds a pulse to the count-gate trigger at the same time as the counters-reset thyratron is fired.

Storage Operation

The print button on the IBM equipment is pressed when it is desired to record a count. This causes the square-wave generator to cease operating at the end of the following ramp. The counters reset is simultaneously disabled and the counters hold the count displayed.

The card punch and printer roll over in sequence, emitting 10 emitter pulses, each. These pulses are fed into the counters, causing them to roll over twice and return to the original displayed count. The square-wave generator is then allowed to operate and the automatic recorder once again begins sensing.

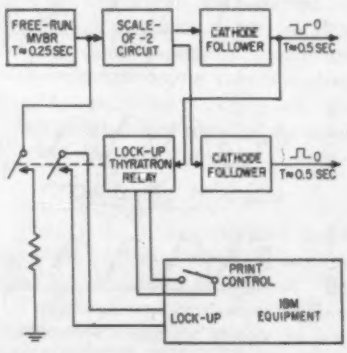


FIG. 4—Square-wave generator comprises free-running multivibrator, scale-of-two circuit and two cathode followers

Figure 4 is a block diagram of the square-wave generator showing the lock-up arrangement. The scale-of-two circuit sharpens up the square wave emitted by the multivibrator and the cathode followers couple multivibrator output to the dependent circuitry.

Read Out

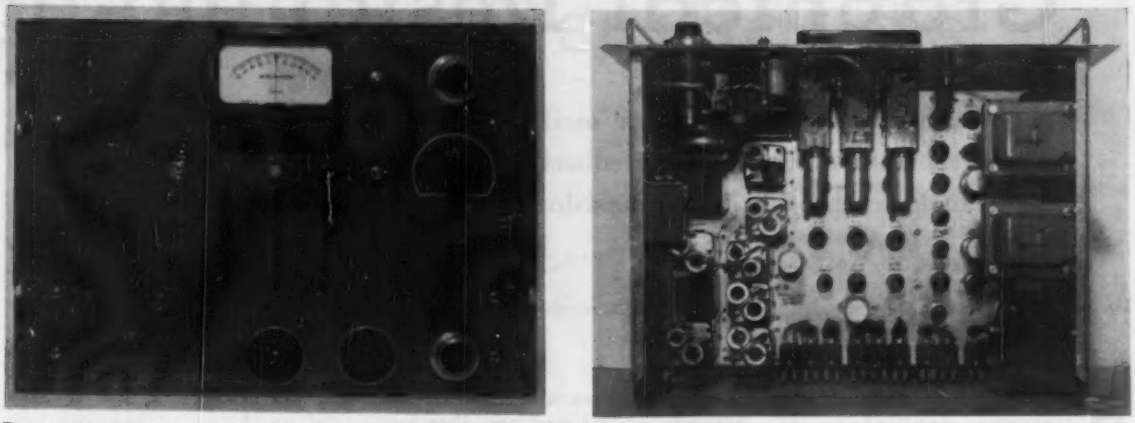
When the print button on the IBM machine is pressed, the cathode of the lock-up thyratron is grounded, permitting the thyratron to fire when the grid is driven positive. This occurs at the start of rise of the following negative square wave (which is also the same time the ramp has ended). When the thyratron fires, a dpdt relay is closed. One of its poles shunts a low impedance across the multivibrator's output, disabling the square-wave generator. The other pole shorts two leads connected to the IBM machines, enabling the machines to roll over.

Figure 5A shows a block diagram of the read-out circuits.

The IBM emitter pulses are fed through a pulse shaper and three diode couplers to the counters. A single negative pulse is emitted by each counter as its count changes from 9 to 0. This pulse is then inverted in the corresponding interstage coupler or inverter circuit to fire a thyratron.

When using the IBM machine for punching, the motion of the card being punched is synchronized with the emitter pulses. That is, the card moves one space for each emitter pulse.

For example, referring to Fig. 5B assume the recorder is locked up at a count of plus 316. Ten emitter



Front and top views of a single-channel automatic digital recorder show extensive use of plug-in units

pulses are fed into the counters. At the time of the first pulse, the card is moved so the punches are above the spaces assigned for the nine digits. For each succeeding pulse, the card is moved a distance of one digit. At the time of the fourth pulse, the punches are over the sixth digit spaces. At this same time, the units counter changes from 9 to 0 and causes the units thyratron to fire, energizing the units column punch that punches a hole in the card at the digit 6 space.

Similarly, at the time of the seventh pulse the punches are over the digit 3 spaces and the hundreds-column punch is energized. At the ninth emitter pulse time, the ten-column punch records a 1. At the tenth-pulse time, all three counters are back to a count of 316.

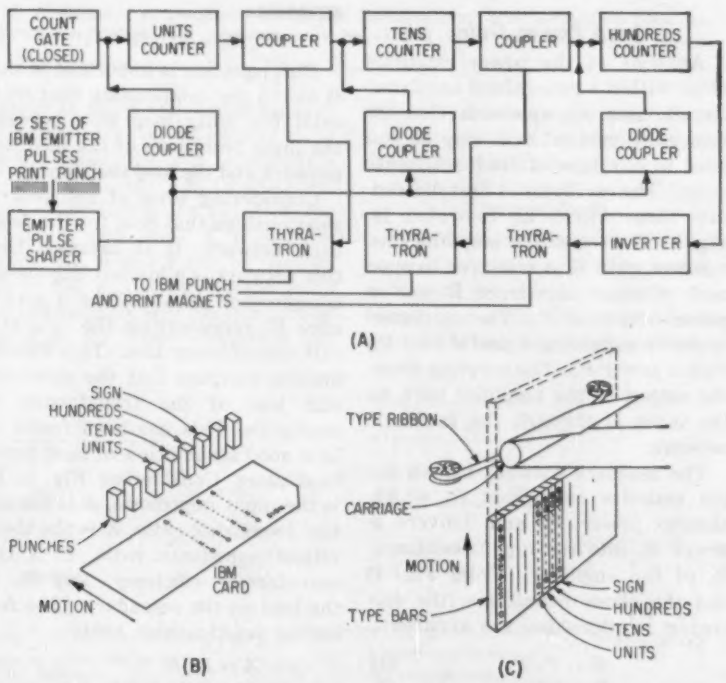


FIG. 5—Read-out circuits, shown in block form, feed punching and printing machines illustrated at bottom

The printing operation is of the same nature as punching except that a type-bar motion instead of a card motion is synchronized with the emitter pulses. Referring to Fig. 5C, each type bar starts to rise with the first emitter pulse and stops rising at the time corresponding to the digit to be printed. After the emitter pulse cycle all type bars are pressed simultaneously against the type ribbon and paper on the carriage and then released.

When the recorder indicates a negative stress, the sign-indicator circuit closes a dpdt relay. One pole completes a circuit which lights a panel light. The other closes a circuit used for the punched card machine and the printer.

Performance

This equipment has been in 24 hr per day, six day per week service. Errors, other than small drifts of the transducers, are rare.

Tube replacement has been the primary maintenance item and is carried out on a preventive basis wherein the tubes, although of premium type, are often replaced at a rate of as much as 10 percent a month.

The equipment has successfully fulfilled the particular objective of recording wind-tunnel data. However, with minor modification, the various basic sections might easily be used by themselves for digital recording of voltages, currents and resistances as well as recording frequency and time-coded data.

Graphical Designing of

Simplified approach to transistor oscillator design uses graphical method. Universal method of designing feedback networks is used with graphic technique to design a highly stable transistor crystal oscillator operating at 1-mc.

By W. R. McSPADDEN* and E. EBERHARD, Motorola, Inc., Western Military Electronics Center, Phoenix, Arizona

A NEW METHOD of designing transistor oscillators described in this article is versatile in that it can be applied with little modification to many different circuits including crystal oscillators. It is comparatively simple, yet yields results accurate enough for most engineering design calculations.

Conditions

The design method is based on Barkhausen's criteria for oscillation which state that: while in a steady-state condition, the gain around the closed-loop portion of any oscillator must be unity, and the phase shift must be zero.

To simplify the problem, these two conditions will be considered separately. The first condition determines whether or not the circuit will oscillate. If the loop gain is lower than unity, the oscillator will not start, and if it is higher than unity, the oscillator will build up in amplitude until limiting occurs somewhere within the loop and the gain is thereby reduced. The second condition determines the frequency of the oscillator. If the phase shift is not zero, the frequency shifts in a direction to make it zero.

*Now at Univ. of Arizona

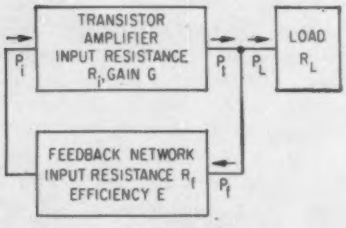


FIG. 1—Generalized oscillator

Design of transistor oscillators involves several problems that are not usually present for vacuum-tube oscillators. First, the ratio of output impedance to input impedance of a transistor is usually high, making it necessary to use an impedance transformer in the feedback network. Second, a transistor stage may have appreciable phase shift between its input and output. In addition, a transistor amplifier may have an input impedance dependant on the load impedance. Furthermore, variations of transistor parameters for different transistors of the same type may be considerable.

Loop Power Gain

Analysis of the power relationships within a generalized oscillator circuit uses an approach that is kept quite general so it may be applied to any type of feedback oscillator.[1] The oscillator is first divided into three blocks as indicated in Fig. 1. The transistor amplifier has a power gain G, a resistive component of input impedance R_i and a power output of P_t. The oscillator is shown supplying a useful load R_L with a power P_L. The coupling from the output of the amplifier back to the input is through the feedback network.

The feedback network has an input resistive component R_f which absorbs power P_f, and delivers a power P_i into the input resistance R_i of the amplifier. From Fig. 1 and the above definitions, the following relationships are apparent:

$$E = P_i/P_f \quad (1)$$

$$P_i = GP_i \quad (2)$$

$$P_L = P_t - P_f \quad (3)$$

Simple manipulation of these relationships yields the following equation:

$$R_L = R_f/(EG - 1) \quad (4)$$

This equation is important in that it shows the relationship that must exist for unity loop gain between the input resistance of the feedback network and the load resistance.

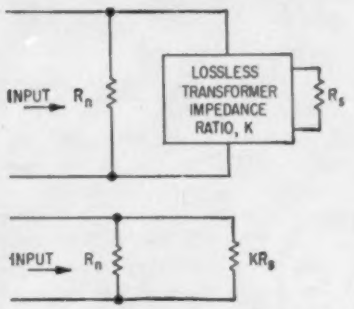


FIG. 2—Simplified representation of a transformer feedback network

Considering some of the general relationships that hold for the feedback network, it is assumed that this network is a lossless impedance transformer paralleled by a resistance R_n representing the open-circuit transformer loss. This simplification assumes that the short-circuit loss of the transformer is negligible. This has been found to be a good assumption in most practical cases. Considering Fig. 2, R_f is the input impedance, A is the actual impedance ratio, K is the theoretical impedance ratio, E is the transformer efficiency, and R_s is the load on the secondary. The following relationships hold:

$$A = R_f/R_s \quad (5)$$

$$A = K/(1 + KR_s/R_n) \quad (6)$$

$$E = A/K \quad (7)$$

The simple relationships ex-

Transistor Oscillators

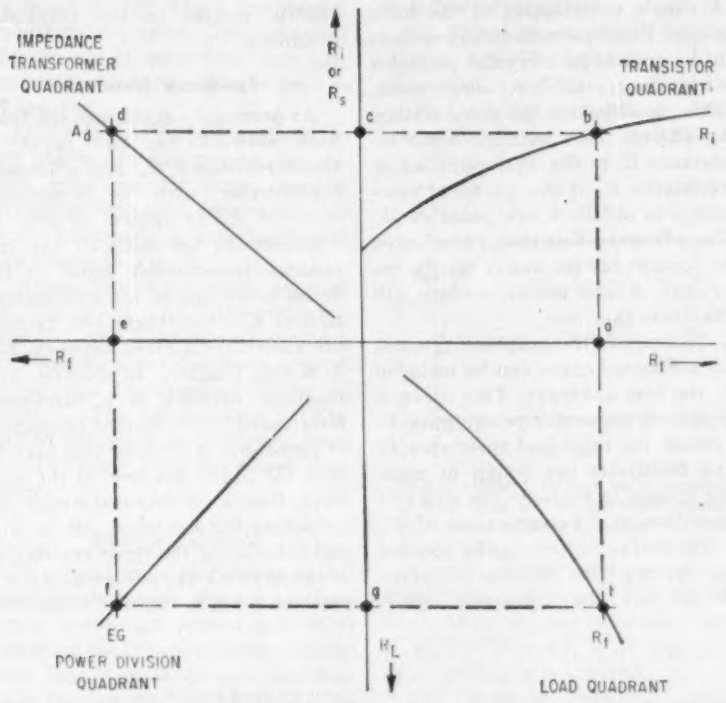


FIG. 3—Example of graphical solution for oscillator loop gain. Depending upon the known parameters, this procedure may be used to solve for other design factors

pressed in Eq. 6 and 7 may be used with good accuracy as long as R_s is not too small. Since it is comparatively easy to obtain R_n by measurement or by using the value of the circuit Q and since K is usually known, Eq. 6 and 7 can be used to obtain the actual impedance ratio and the transformer efficiency when loaded by R_s. These quantities can also be measured experimentally as functions of R_s if a higher degree of accuracy is desired.

Excess Gain

Since it is not feasible to design an oscillator with exactly unity loop gain, any practical oscillator has excess loop gain. This fact simply causes the amplitude of oscillation to increase until limiting of some sort occurs and the actual gain exactly equals the minimum loop gain required to sustain oscillation. A factor τ is defined as the ratio of the actual class-A amplifier gain G_p, to the minimum amplifier gain G necessary to permit oscillation.

$$\tau = G_p/G \qquad (8)$$

When $\tau = 1$, oscillation is just possible.

For some cases a mathematical analysis of loop gain may be simple, but the problem is often complicated by the interdependence of several parts of the oscillator loop.

Graphic Method

The graphical method of approach used here was evolved with the idea of aiding the designer to solve this problem. It not only makes the solution easier, but also presents clearly the effect of varying the several circuit parameters.

Consider in detail the diagram shown in Fig. 3. Four resistance axes have been plotted. The upper right-hand quadrant is bounded by R_l, the total collector load on the transistor, and R_i, the input resistance of the transistor amplifier. In most simple oscillator circuits $R_i = R_s$; however, this is not the case for certain types of crystal oscillators. This quadrant is called the transistor quadrant in which a curve of R_i against R_l is plotted for the transistor to be used. The upper left-hand quadrant is bounded by the axes R_i and R_f. This quadrant is

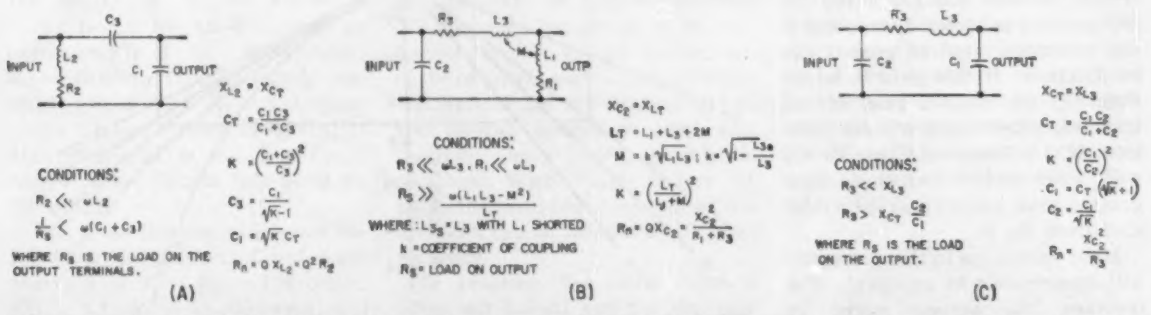


FIG. 4—Circuit and simplified design equations for three common types of feedback network. (A) L-C-C type (B) C-L-L type (C) C-L-C type. Type (C) is for a Colpitts oscillator

the impedance transformer quadrant and in it a straight line representing the actual transformation ratio A of the impedance transformer is drawn based on Eq. 5.

The lower left hand quadrant, bounded by the axes R_t and R_L, is known as the power division quadrant and is related to Eq. 4. This quadrant contains a straight line relating R_t and R_L to a given efficiency-gain product EG. In this quadrant it is possible to design for a given value of τ by simply making G equal to G_p/τ.

The lower right hand quadrant is termed the load quadrant. It contains a curve showing the relationship between R_t and R_L for a fixed value of R_t.

Using Diagram

To use this diagram, assume it is desired to operate with a total transistor load represented by point a on the R_t axis using a known impedance transformer having an actual transformation ratio A_a and an efficiency E. This value of A_a corresponds to a particular curve in the second quadrant. From point a project a vertical line to b, a horizontal line to c and d, and another vertical line downward to point e. Also project downward from a to h and horizontally to g. The particular R_t curve used in the fourth quadrant must agree with the value of R_t from point e. Point e represents the value of the input impedance of the feedback network and point g represents the value of R_L which in combination with R_t gives the original assumed value of R_t.

By simply extending lines g-h and d-e until they intersect at f, the efficiency-gain product necessary to just produce oscillation can be found. Since E was given and the EG product is known from point f, the minimum required gain G can be obtained. If this gain is larger than G_p, the class-A gain of the transistor, the circuit will not oscillate. If G is less than G_p oscillation will occur and τ (which is now greater than unity) may be avaluated from Eq. 8.

Many variations in this procedure will immediately be apparent. For instance, the design might be started with R_L, R_t, τ and E known and the impedance matching network to be determined.

Advantages

One of the advantages of this design procedure is its versatility. A simple modification of the basic plot of Fig. 3 permits this procedure to be applied to a crystal oscillator using the crystal in its series mode. This modification is accomplished by adding the transistor input resistance R_i to the equivalent series resistance R_t of the crystal at resonance to obtain a new value of R_t. The efficiency E is then reevaluated to account for the power loss in the crystal. A later design example will illustrate this case.

To simplify the graphical process, an additional curve can be included in the first quadrant. This curve is a plot of transistor power gain P_t against the total load resistance R_t and facilitates the design by making it easy to evaluate the effect of operation at different values of R_t.

The design process can be speeded by starting with families of curves in all but the transistor quadrant. These can be plotted to cover a wide variation of impedance ratios, efficiency gain products, and values of R_t, R_L and R_t. If curves of power gain and R_t are known for limit transistors, these can also be readily plotted in the transistor quadrant.

Feedback Network

As previously explained, the feedback network has two parts: a shunt resistance R_n, and a lossless transformer with an impedance ratio of K, as shown in Fig. 2. Theoretically the study of any impedance transformer could be reduced to a study of the two factors R_n and K. Once these two factors are known for a given network, Eq. 5, 6 and 7 apply. In general, the feedback network is a band-pass filter tuned to the desired frequency of operation. Assuming that high-Q coils ($Q > 10$) are used in the network, then R_n is obtained simply by unloading the secondary ($R_s = \infty$) and calculating the input resistance of the network at resonance. An expression for K is obtained by assum-

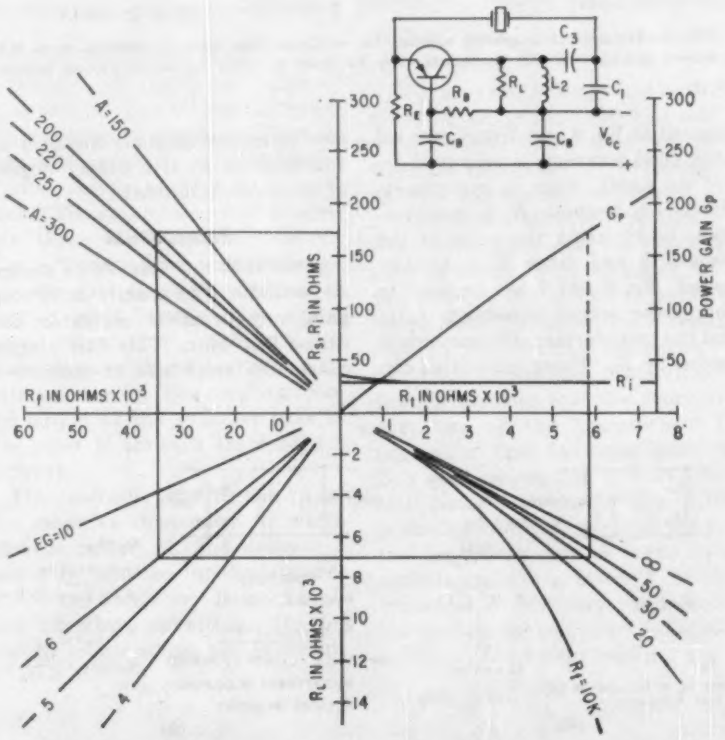


FIG. 5—An example of crystal oscillator design with an L-C-L feedback network. Transistor type is a 2N247 and the desired frequency of oscillation is 1 mc

ing lossless components of the filter and calculating R_f as a function of R_s.

Because of the assumption that the short-circuit losses are zero, there will always be some minimum value of R_s for which the design equations are valid. This relationship should be stated for each network since the errors can be serious if ignored.

Using the principles outlined in the above two paragraphs, the design equations for three common networks have been developed. The basic relationships and limitations are shown in Fig. 4.

An oscillator using the network of Fig. 4C is a Colpitts oscillator, and if L_2 and R_2 of this network are replaced by a parallel mode crystal, it becomes the familiar Pierce oscillator. The assumptions of Fig. 4C do not apply in the latter case; modifications may be found elsewhere.[2]

Design Example

A crystal oscillator with an L-C-C network has been chosen to illustrate the design procedures. It is assumed that the transistor, crystal and load resistance are specified. The frequency of operation is to be 1 mc, the transitor is to be a type 2N247 with a 6,900-ohm useful load and the crystal is to be a CR-19/U. Referring to Fig. 5, the design then proceeds as follows:

(1) Design the transistor bias network and evaluate the input resistance and power gain at 1 mc for several values of R_f. See any standard transistor text for the bias network design. Plot R_i and the power gain G_p against R_f as in Fig. 5. For this example R_E = 4,700 ohms; R_B = 180,000 ohms; I_c = 1 ma; V_{ce} = 3 v; R_i of the crystal = 140 ohms.

(2) Locate all known points or curves on Fig. 5. R_L = 6,900 ohms; R_i = 34 ohms (approximately constant); $R_s = R_i + R_1$ = 174 ohms.

(3) Choose a value of R_f that is high compared to R_L. Let R_f = 35,000 ohms. Locate this point on the graph.

(4) Close the loop and record the following parameters: R_L = 6,900 ohms; A = 200; R_s = 174 ohms; EG = 6.1; R_f = 35,000 ohms; and G_p = 170.

(5) Now choose L_2. For this example a small ferrite toroidal inductor was available having the following constants: L_2 = 286 μh; Q = 147; R_2 = 12.2 ohms; the tuning capacitor C_t required to resonate with this coil is 90 $\mu\mu$f.

(6) Calculate R_n and K: $R_n = QX_{L2}$ = 265,000 ohms; $K = AR_n/(R_n - AR_s)$ = 231.

(7) Calculate efficiencies and loop gain: $E_1 = A/K$ = 0.867 = transformer efficiency; $E_2 = R_i/R_s$ = 0.195 = crystal efficiency; $\tau = E_1 E_2 G_p/EG$ = 4.7. With this value of τ oscillation is assured.

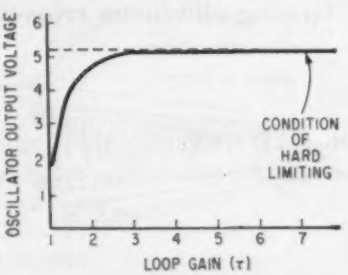


FIG. 6—Output voltage as a function of loop gain for an oscillator biased near center of class-A region

(8) Calculate network capacitors: $C_1 = \sqrt{K}\,C_t$ = 1,370 $\mu\mu$f; $C_2 = C_1/(\sqrt{K} - 1)$ = 96.5 $\mu\mu$f.

The above oscillator was constructed and oscillated strongly as would be expected with the chosen value of τ. When tested for stability with respect to supply voltage variations it showed a frequency shift of 0.03 ppm for a 1 percent change.

Output Voltage

The determination of oscillator output voltage is often an important consideration in the design. The prediction is tied closely to the loop-gain analysis. In fact, the problem can be solved completely if the following two factors are known: the curve of power gain against output voltage with the desired load and at the desired operating point and the minimum gain G to permit oscillation. With these factors at hand, the resulting amplitude of the oscillator can be predicted with good accuracy.

In practice, the above data is often not known and the designer may want to make a rough estimate of the output voltage without obtaining the power gain versus output voltage curve. If the oscillator is biased such that its operating point is fixed and is near the center of its class-A region, the output voltage can be estimated from the amount of excess loop gain. This estimate makes use of the fact that limiting will occur sharply and gain will fall off rapidly when the a-c peak voltage at the collector equals the d-c collector voltage.

Experimental data shows (see Fig. 6) that if the loop gain, τ, is greater than about 1.8, the output voltage will be within about 15 percent of this maximum theoretical value. If τ is greater than about 2.5 the output voltage will be within about 5 percent of its maximum theoretical value. This relationship holds only if the amplitude limiting is quite sharp. For instance, if the transistor is biased near cutoff, limiting will start at much lower values of collector peak voltage, but the limiting action will not be as sharp and the output amplitude will continue to increase, even though the gain decreases, until the peak a-c voltage equals the d-c voltage. In this case it would be necessary to know the gain characteristic to predict the output voltage.

Oscillator Frequency

To investigate the factors influencing the frequency of the oscillator consider the Barkhausen criterion that the phase shift around the loop must be zero for any oscillator in a steady-state condition.

When the amplifier portion of the circuit is a transistor the assumption that the phase shift equals 180 deg through the device is not nearly good enough and it usually becomes necessary to consider the phase shift within the transistor to predict the operating frequency with accuracy. For best frequency stability the amplifier should have little phase shift. The factor of primary importance here is the magnitude of the phase angle associated with the transistor transfer characteristics h_{fe} or h_{fb}.

References

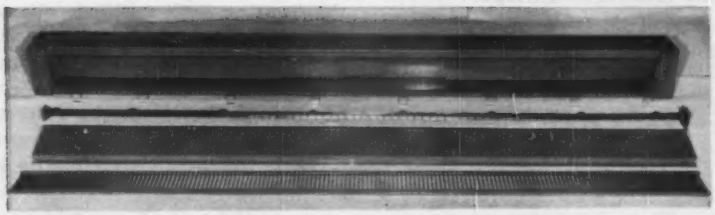
(1) E.Eberhard, Chapter 14, "Handbook of Semiconductor Electronics", McGraw-Hill Book Co., Inc., New York, 1956.
(2) Final Report, Army Contract DA-36-039-SC-72837, Signal Corps Engineering Laboratories.

Slotted Waveguide Array

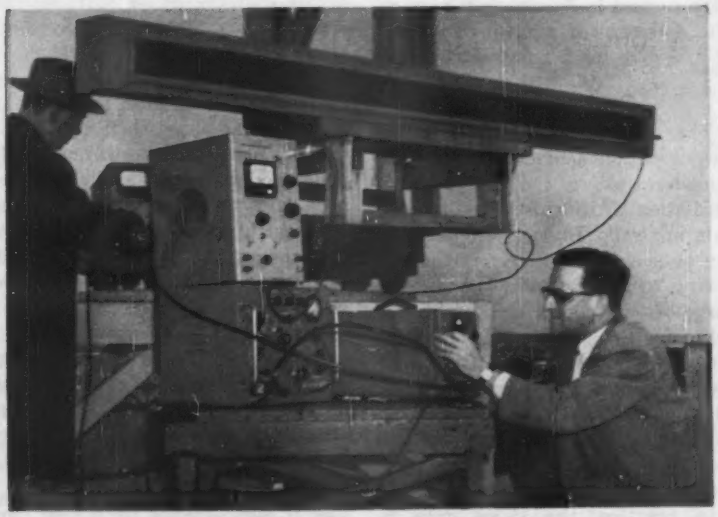
Rectangular slotted waveguide antenna, designed for marine radar applications, uses waveguide with 126 inclined slots, a 30-degree flared horn, metal grating and window. Full length chokes between waveguide and horn lick back-radiation problem. Grating eliminates cross-polarized radiation

By H. G. BYERS and M. KATCHKY,

Canadian Arsenals Limited, Instrument and Radar Division, Toronto, Ontario, Canada



View of antenna showing casing, spring clips, slotted waveguide—minus matched termination, horn plate and metal plate grating. Not shown are Fiberglas tape and protective Plexiglas window



Pattern measurements being taken on the 12-foot, X-band slotted waveguide antenna. Array was developed for marine radar to minimize mechanical loading effects as well as spurious target return resulting from back radiation

ANTENNAS commonly used in marine radar are truncated parabolic reflectors with a dipole or waveguide horn feed. Although this type of antenna usually has a good radiation pattern with low near-in side lobe level, it presents considerable wide angle and back radiation problems. These radiations, which create false masking echoes when navigating in narrow channels or near massive land targets, are difficult to suppress completely. Practical efforts to minimize the back radiation from the antenna result in a narrow vertical beamwidth, which makes radar coverage unreliable particularly when ships are navigated in heavy seas.

An investigation to find a more suitable type of antenna for marine radar led to the development of the slotted waveguide array, which meets all the electrical requirements and has all the advantages not inherent in the reflector-type antenna.

General Description

Construction details of the antenna are shown in Fig. 1. The waveguide feed connects the slotted waveguide array, which is inside the casing, to the rotary joint in the gear box (not shown). Briefly,

For Marine Radar

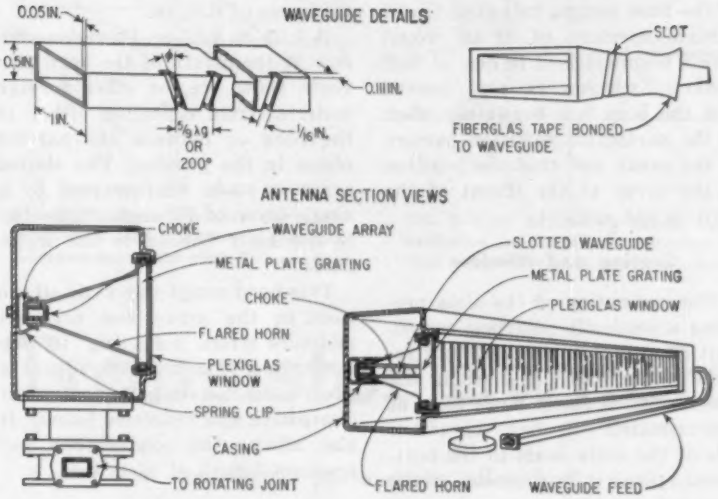


FIG. 1—Section views of compact slotted-waveguide antenna. Internal parts are protected from weather by the casing and Plexiglas window.

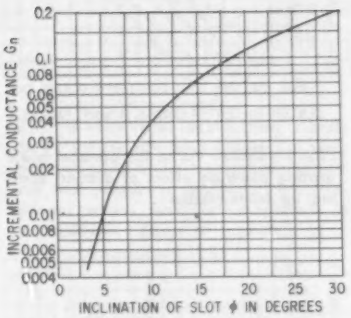


FIG. 2—Variation of slot conductance with angle of inclination for 1/16-in. wide slots cut in RG-52/U waveguide

the antenna consists of a rectangular waveguide that has inclined slots cut at regular intervals in one of the narrow walls. The waveguide is at the throat of a horn, the side containing the slots being nearest the horn mouth, or aperture. The horn extends the full length of the waveguide. The waveguide and horn are enclosed in a casing that mounts and protects the internal antenna elements from the weather.

Full length chokes, located between the waveguide and horn, prevent back radiation. A metal-plate grating, mounted across the horn aperture and extending the full length of the array, eliminates cross-polarized radiation from slots.

Advantages

This antenna is compact and requires considerably less volume and frontal surface than a parabolic reflector antenna with the same vertical and horizontal beamwidths. The aperture efficiency, expressed as the ratio of the actual antenna gain to the theoretical maximum gain for a given antenna is high in this design. Thus, it is reasonable to expect that the wind and weight loading on the rotating mechanism is much less with this antenna.

Inclined slots in the narrow side of the waveguide can be machined easily and accurately. Since this is the only part of the construction in which the dimensions are critical, the production and inspection costs are considerably lower. A further advantage of the slotted waveguide type of antenna is the beamwidths that can be obtained, both in the horizontal and vertical plane. For example, it is possible to obtain half-power horizontal beamwidths from 0.6 to 2.5 deg and vertical beamwidths from 15 to 25 deg or more by making minor changes in design and production tooling.

Design Consideration

Inclined slots are used in the narrow wall to satisfy marine radar requirements for horizontal polarization.[1]

To obtain sufficient bandwidth the design must be a nonresonant traveling-wave array, for example, an end-fed array of resonant slots at nonresonant separation and terminated in a matched load.[2] The squint angle, the angle between the normal to the array and the line of maximum radiation, inherent in nonresonant arrays is not a serious disadvantage in this application because bearing calibration and alignment of the heading marker is usually performed on fixed targets of known bearing. The change in squint angle with wavelength is small over the operating range of the magnetrons commonly used in marine radar transmitters. The operating range is usually 3.19 to 3.21 cm. In cases where this deviation is important, a correction factor depending on magnetron wavelength can be applied to the bearing calibration on the display.

Array Design

The basic formulas used in the development of the slotted waveguide was derived during the war years.[2, 3]

The low side-lobe level requirement can be met only by using a relatively steep taper of radiated energy along the array aperture. Fortunately, inclined slots in the narrow wall satisfy this requirement. The slots behave electrically like shunt-coupled elements to the transmission line, with the value of their normalized conductance being closely related to the angle of inclination by the relation for G_n given by $G_n = A \sin^3 \phi$ (for values of ϕ less than 15 deg) where A is the constant of proportionality and G_n is the normalized conductance.

The value of A is influenced to some extent by the type of dielectric tape used for weatherproofing, and is best determined empirically. The depth of cut into the waveguide determines the effective length of the slot. Although the slots are at

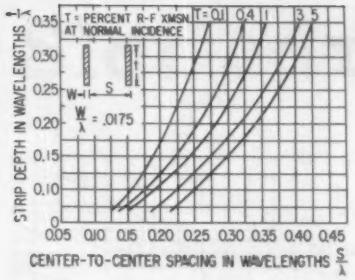


FIG. 3—Design curve for parallel plate grating showing effect of grating spacing on transmission

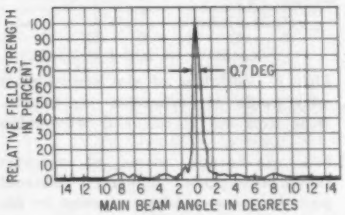


FIG. 4—Typical horizontal radiation pattern of slotted waveguide antenna for wavelength of 3.2 cm

a nonresonant spacing, each slot must be a resonant element for optimum pattern, and this is achieved by controlling the depth of cut to the value shown in Fig. 1. Figure 2 shows the variation of slot conductance with angle of inclination.

Since power radiated by each slot is proportional to its normalized conductance, the desired taper can be achieved by simply calculating the required angle of inclination of each slot. With the slots alternately inclined the phase is reversed by 180 deg and this enables the slot spacings to be less than a free-space wavelength.

Without phase reversal, the spacing between slots would have to be greater than a free-space wavelength to achieve the required phase relationship between successive slots, and this would create large second principle order lobes in the horizontal radiation pattern.

Horn Design

The required vertical beamwidth is obtained by placing the array at the throat of a sectoral horn that extends along the full length of the array. To keep the size of the horn within practical limits, a flare angle is set at 30 deg. The 30-deg flare can be used to cover the full range of vertical beamwidths from 15 to 25 deg or more, between half power points, by simply changing the horn length hence the vertical aperture.

Experimentation on a mock-up of the final design indicated that a vertical aperture of 4½ in. would give a beamwidth of 16 deg. at half power. Experiments also proved that the horn has negligible effect on the horizontal radiation pattern of the array and that the position of the array at the throat of the horn is not critical.

Grating and Window

The inclination of the slots produces a vertically polarized component of radiation that does not reverse phase with inclination, and this results in fairly large lobes at approximately 40 deg on either side of the main beam in the horizontal plane. To remove these cross-polarized lobes, some type of filter must be used across the horn aperture that will have negligible effect on the normal horizontally polarized radiation. A grating, consisting of thin, vertical, parallel metal plates that form short lengths of waveguide for the vertical components of the electric field, acts as the filter. With the plates spaced less than one-half free space wavelength apart, the waveguide is below cutoff and the vertically polarized field is highly attenuated. The exact spacing is based on empirical data (Fig. 3).[4]

The percent r-f transmission for normal incidence is shown as a function of the center-to-center spacing between plates and the depth of the plates.

Without the grating, the amplitude of these cross-polarized lobes is 15 to 17 percent in field strength when referred to the peak of the horizontally polarized radiation pattern. To reduce these lobes to one percent, a transmission factor of 0.5 percent is required. The desired results are obtained with a grating space of 0.5-in., center-to-center, 0.625-in. deep and a plate thickness of 0.02 in.

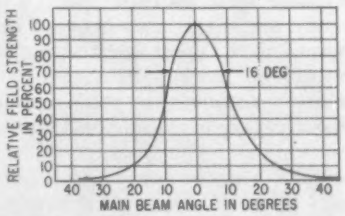


FIG. 5— Typical vertical radiation pattern of slotted waveguide antenna for wavelength of 3.2 cm

A 0.04- to 0.05-in. Plexiglas window at the mouth of the horn prevents snow, ice, or other foreign material from collecting either in the horn or between the parallel plates in the grating. The slotted array is made weatherproof by a single layer of Fiberglas tape that is thermally bonded to the waveguide.

This bond completely seals all the slots in the array and prevents moisture from collecting in the waveguide. The tape introduces a small reduction in gain because of dissipative and reflective losses. It also affects the conductance and resonant length of each slot.

Matched Termination

The matched termination is essential to the performance of a nonresonant array because it eliminates reflections from the end of the array which would otherwise be radiated as a side lobe in the horizontal plane at an angle from the normal equal and opposite to that of the main beam. Also, the matched termination presents the required impedance at all points along the array to ensure the proper distribution of power to each radiating element. The termination must handle at least four percent of the total transmitter power and withstand vibration and shock.

The material selected is a special grade of polyiron, which is machined to a special shape and is bolted to the narrow wall of the waveguide. The termination has a maximum vswr of 1.05, and is an integral part of the slotted array.

Figure 4 shows a typical horizontal pattern and Fig. 5 shows a typical vertical antenna pattern.

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(2) R. E. Bell, Non-Resonant Arrays, National Research Council of Canada PRA-128, May 1945.
(3) E. W. Guptill and W. H. Watson, Longitudinally Polarized Array of Slots, National Research Council of Canada, PRA-104, Dec. 1943.
(4) Gratings and Screens as Microwave Reflectors, M.I.T. Rad. Lab. Report 54-20.

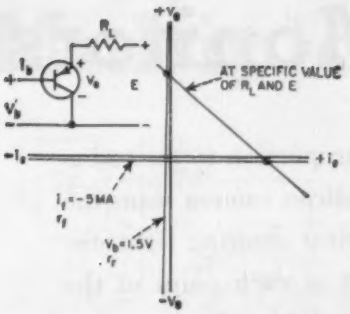


FIG. 1—Maximum power transfer occurs when R_L is geometric mean of r_r and r_f. Characteristics exist when $E < v_b$.

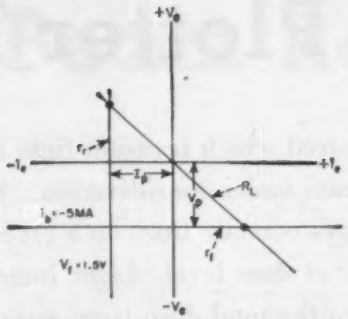


FIG. 2—Four parameters shown were evaluated for transistors connected in their inverted, or common-collector form

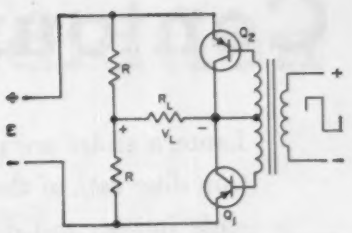


FIG. 3—Low-level modulating circuit. If V_p values are kept below 0.1 millivolt by using audio transistors, the output will contain a zero-signal a-c component whose maximum magnitude is 0.5 millivolt. Effect of mismatch in r_r and r_f is minimized if $R_L >> r_f$

Transistor Switch Design

Four significant parameters affecting transistor switches are tabulated for eight transistor types. Data presented permits designer to match transistor pairs for optimum operating characteristics

By **ARTHUR GILL***, Research Division, Raytheon Manufacturing Co., Waltham, Mass.

TRANSISTORS can be used as sensitive spst switches by appropriately controlling base-to-collector voltage.[1] A *pnp* transistor switch and its emitter-collector characteristics are shown in Fig. 1.

When base voltage is positive, switch exhibits high resistance r_r; when negative, low resistance r_f. Ratio r_r/r_f is a measure of switch efficiency—the higher the ratio, the lower the average power dissipated in the switch as compared to that delivered to load resistor R_L.

An enlarged view of the v_c—i_c field near the origin is shown in Fig. 2. With the switch on, residual voltage V_p exists across the load; with the switch off, residual current I_p flows through the load. These two quantities impose a lower limit on signal voltage E.

Parameters r_r, r_f, V_p and I_p are significant when transistors are employed with low-level modulators. Mean value and deviation of the four parameters are given for various types of transistors in Table I. Deviation is defined as the amount by which 50 percent or more of the samples varied from the mean value. All transistors were switched on by a forward current of five milliamperes and off by a reverse voltage of 1.5 volts. It was observed that I_p and r_r were subjected to considerable drift while V_p and r_f remained constant.

* Now with the University of California

Table I—Switching Parameters for Various Types of Transistors

Type	No. of Samples	V_p in mv		r_f in ohms		I_p in ua		r_r in meg	
		Mean	Dev.	Mean	Dev.	Mean	Dev.	Mean	Dev.
Audio									
2N131	100	1.7	0.1	11	1.5	0.23	0.03	5.6	3
Bilateral									
CK870	50	5.6	1.5	2.3	0.2	3.1	0.08	17	5
CK871	50	4.3	0.9	1.7	0.2	3.3	0.09	14	6
Radio Frequency									
CK760	25	1.8	0.3	1.9	0.2	0.17	0.04	90	40
CK761	25	1.4	0.3	1.5	0.2	0.15	0.05	55	45
CK762	25	1.4	0.2	1	0.1	0.25	0.05	42	25
High Beta									
CK754	25	1.1	0.05	1.8	0.1	0.21	0.04	70	30
Silicon									
CK791	22	2.2	0.2	28	12	0.015	0.002	>1000	

Efficiency of Modulators

Sensitivity of modulators can be increased by connecting the transistor switches in opposition to cancel the effects of V_p and I_p. Since it is easier to match units with respect to V_p, the designer should strive to construct the modulating circuit so that the effect of I_p is negligible.

REFERENCE

(1) R. L. Bright, Transistor Chopper for Stable D-C Amplifiers, ELECTRONICS, p 135, Apr., 1955.

Contour Plotter Monitors

Lantern slides are prepared which transmit light in proportion to the radiation dose rate of the beam under consideration. A vidicon camera scans the slide images and displays contour lines on a crt monitor showing light distribution as a function of dose level. Light intensity at each point of the screen is proportional to the total dose from several radiation beams

By **GLEN H. SANDBERG,** Department of Radiology, College of Medicine, University of Illinois

RADIOLOGISTS ARE CONCERNED with the dose distribution in multiple-port radiation therapy, which results from superimposing several beams of ionizing radiation. With the multiple-port technique a large total dose is delivered to a lesion deep in the body where the beams cross, and a minimum dose is delivered to surrounding healthy tissues.[1]

Dose distribution has been determined in the past by a number of methods which are either tedious or inaccurate, such as manually adding doses from the several beams delivered to the point in question.[2] The procedure must be repeated for each point to be evaluated and requires hours to evaluate enough points for plotting isodose curves. If the radiologist decides to try a slightly different arrangement of fields a completely new evaluation of dose distribution is needed.

Multiple-port radiation therapy delivers a large total dose to a lesion deep in the body and a minimum dose to surrounding healthy tissue

With the instrument to be described, isodose curves are displayed continuously, responding instantaneously to changes in the treatment plan under consideration.

Addition of Fields

An optical analog system is used to add the ionization dose distributions from several radiation beams. Lantern slides are prepared which transmit light in proportion to the dose rate at each point in the section of the beam under consideration.[3]

When images from a number of projectors are superimposed on a screen, the light intensity at each point of the screen is proportional to the total dose from the several radiation beams, at the corresponding point in the cross section of the patient. This process is shown in Figs. 1 and 2.

The video amplifier used to drive the germanium diode gate circuits is shown in Fig. 3. A grounded-grid amplifier V_{1A} is driven from the 0.5-v, 72-ohm output of the camera. Cathode follower V_{1B} isolates V_{1A} from the input capacitance of V_{2A}, a second voltage amplifier which drives the cathode follower output amplifier, V_{3A} and V_{3B} in parallel.

Inverse feedback is provided to the grid of V_{1A} by R_1 and C_1 in series with the 10,000 ohm load of V_2 stablizing the overall gain at about 50 and improving the high-frequency response. The gain is flat within about 1.5 db. from d-c to 5 mc.

Video amplifier used to drive germanium diode gate circuits

Five gate circuits are used to simultaneously generate five independent isodose curves. Each consists of two type 1N55B germanium diodes connected in series opposing, with current bias of about 100μa to make both conduct when the input voltage is within about 0.1 of the reference level on the control panel.

The input terminals of the five gates are connected together and to the cathodes of V_2 through L_2 which picks up a 70-mc signal from L_1, the tank coil of oscillator V_{2B}. The output terminal of each gate is connected through T_1 to a bypass capacitor and to a potentiometer which provides reference voltage. Mixing transformer T_1 connects the gate outputs to the r-f input of the monitor.

A 21-in. home television receiver is used to display the video signal directly from the camera and to superimpose the iosdose curve display produced by the r-f signal from the gate circuits. Gain of the monitor r-f circuits is controlled from

Multiple-Beam Radiation

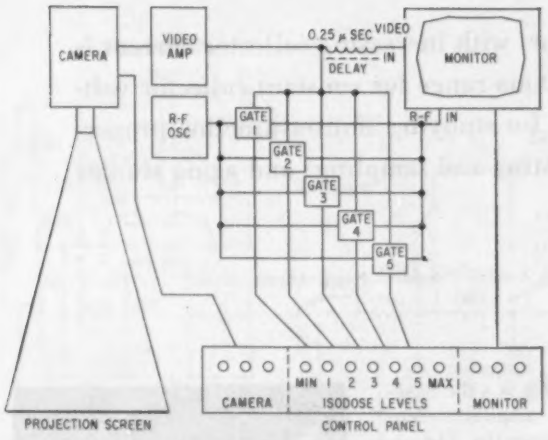


FIG. 1—Vidicon pickup tube produces a voltage which varies according to radiation dose distribution as arranged by setting at each individual beam level

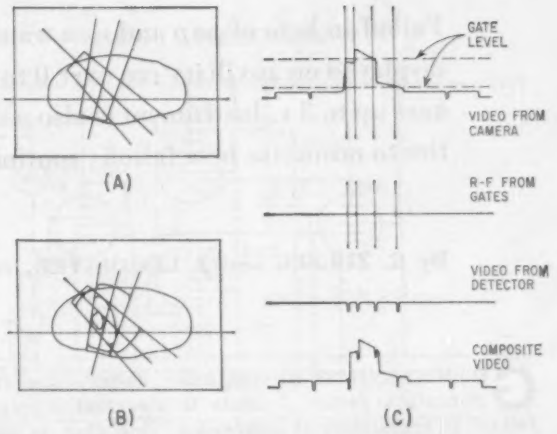


FIG. 2—Composite screen image projected from lantern slide replicas of therapy beams (A) appear on monitor display with curves (B). Waveform sequence (C) from camera to monitor

the front panel by a potentiometer connected to the agc line. Because of delay in the r-f and i-f circuits of the receiver, the video signal must be delayed by about 0.25 μsec.

Operation

A tracing of the patient's body contour at the treatment site is made on tracing paper or transparent plastic[1,2] and placed over the projection screen. Lantern slide replicas of the appropriate radiation fields are placed in projectors. A calibrated step-wedge is placed in an additional projector so that its projected image is outside the body cross section. The reference voltage potentiometers are adjusted to give isodose curves at the desired points on the calibration wedge, for example at 98, 90, 70, 50 and 20 percent of the maximum dose. The radiation field replicas are adjusted, by sliding on the horizontal stages of the slide projectors. Individual brightnesses is adjusted to give the optimum arrangement of isodose curves in terms of the tumor outline and other medical considerations.

Record

When the optimum arrangement has been found the monitor screen is photographed to record the orientation of each field and the resulting dose distribution. To find the fraction of the prescribed maximum dose delivered in each field, all projectors are switched off except those for the field in question and the calibration wedge. An isodose curve is adjusted to appear at the maximum dose rate in the field being measured; the point where this isodose curve appears on the calibration wedge gives the fractional dose in terms of the prescribed maximum.

The author is grateful for the support of W. S. Moos, and R. A. Harvey, of the Univ. of Ill. and for the mechanical work of E. S. Spongberg.

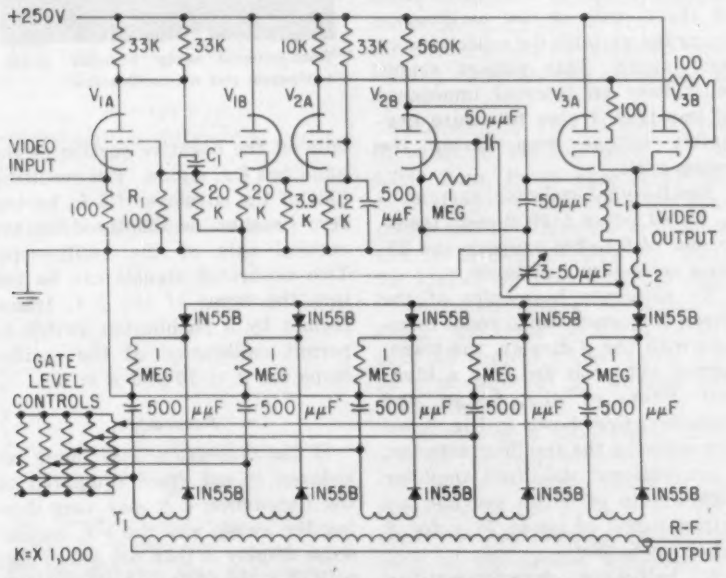


FIG. 3—Five gate circuits simultaneously generate five independent isodose curves

References

(1) H. E. Johns, "The Physics of Radiation Therapy," Charles C. Thomas, Publishers, 1955.
(2) L. L. Haas, Radiology, 61 P. 222, Aug. 1953.
(3) W. S. Moos, and G. H. Sandberg, *Proc.* ISA 11, 1956.

Sweep Equipment Displays

Falloff in beta of *pnp* and *npn* transistors with increasing collector current is displayed on auxiliary cro over 0 to 200-ma range for constant collector voltages up to 8 v. Instrument is also useful for studying emitter-junction properties to minimize beta falloff; routine testing and sampling; and aging studies

By R. ZULEEG and J. LINDMAYER, Sprague Electric Company, North Adams, Mass.

GROUNDED-EMITTER current amplification factor β tends to fall off in transistors at increasing collector currents due to decreasing injection efficiency of the emitter.

The equipment to be described displays the β versus I_c characteristic of *pnp* and *npn* transistors with an adjustable sweep of the collector current from 0 to 200 ma and a beta range from 0 to 200.

System Operation

Figure 1 shows the basic system and Fig. 2 the complete circuit diagram. Collector voltage V_c is kept constant while the base current is composed of a low-frequency large-amplitude sweep current I_b and a 10-kc small-signal current δI_b. Accordingly, the collector current consists of a large-signal sweep component I_c and a small-signal a-c component δI_c. With δI_b constant during the sweep, δI_c reflects directly the variation of β with I_c, as

$$\delta I_c = \beta \, \delta I_b \qquad (1)$$

The sweep generator is a conventional 10-cps linear-sawtooth oscillator with a cathode follower output. Also available is a d-c base-current supply for manual sweeping that is not shown in Fig. 1. Both are built above ground level to allow polarity reversal for *npn* or *pnp* operation.

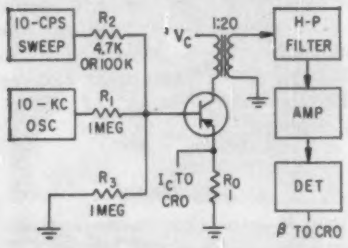


FIG. 1—Basic sweep system components

The small-signal base current is provided by a Wien-bridge type signal generator, tunable from 8 to 12 kc with a 10-v output, fed through a 1-megohm resistance into the transistor base. Collector current I_c is measured across a 1-ohm resistance, resulting in a 0.2-v signal for a collector current of 200 ma. This voltage drop is displayed on a d-c oscilloscope.

A d-c ammeter, not shown in Fig. 1, is in the collector circuit and provides for direct calibration of the I_c axis on the oscilloscope using the variable d-c collector-voltage supply. This voltage supply must have an internal impedance of less than 1 ohm to assure negligible voltage drop during the sweep cycle.

Small-signal collector current, δI_c, is fed into a 1:20 step-up transformer of 0.1-ohm primary and 25-ohms secondary resistance.

To eliminate harmonics of the sweep frequency which could interfere with the β display, the transformer output is fed into a high-pass filter, of the design and characteristics shown in Fig. 3, before entering the amplifier detector. A conventional stabilized amplifier with a gain of 50 db provides an output signal of up to 70 v for β values up to 200.

A half-wave detector-rectifier cuts off the negative portion of the amplified δI_c signal. The resulting half of the envelope of δI_c, having zero baseline, is displayed on the vertical axis of the oscilloscope. Two calibrated signals can be fed into the input of the δI_c transformer by a pushbutton switch to permit calibration of the oscilloscope for $\beta = 10$ and $\beta = 50$.

Typical patterns of β versus I_c at V_c equal to −2 v for alloy-junction (left), surface-barrier (center) and micro-alloyed diffused (right) transistors

Rack-mounted setup contains sweep equipment and d-c oscilloscope

Accuracy

If the transistor base input resistance is not small compared to the impedance, δI_b may vary during the sweep and the δI_c oscilloscope display is then not a true display of β. In addition to base input

Transistor Beta

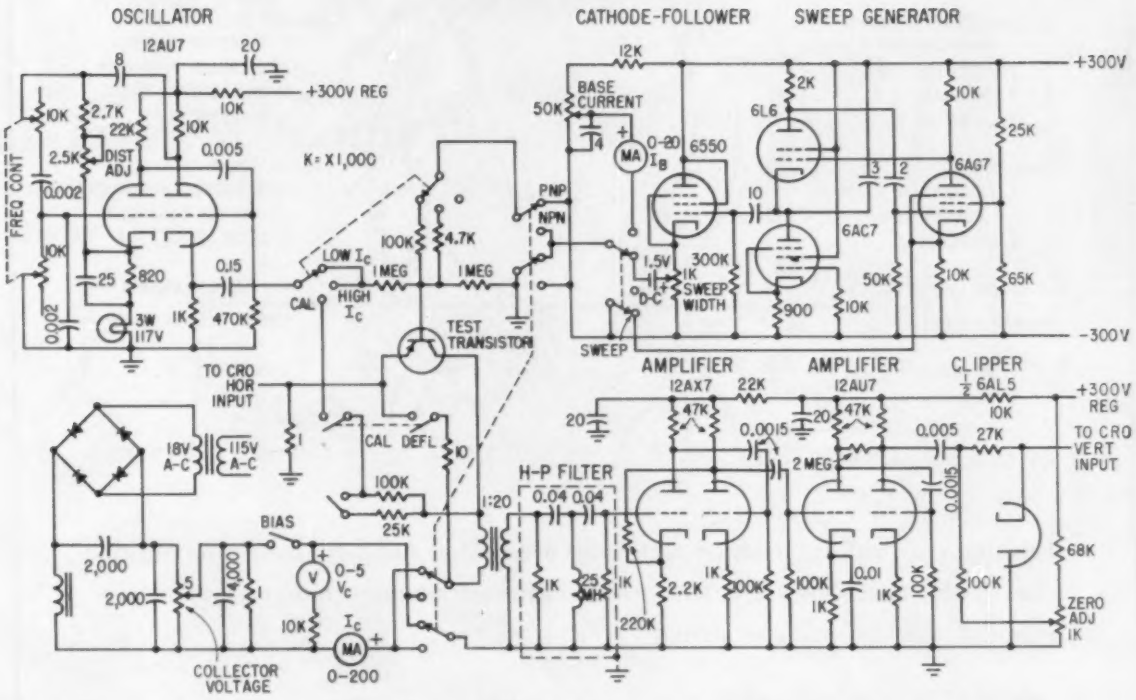


FIG. 2—Complete circuit diagram with exception of power supplies for amplifier-detector, oscillator and sweep generator

resistance R_1, R_2 and R_3 in Fig. 1 must be large compared to the resistance of the δI_b current generator which is essentially R_i.

The base input resistance of the transistor is

$$R_i = r_e\beta + r_b \qquad (2)$$

and the emitter differential resistance is

$$r_e = KT/(qI_e) \qquad (3)$$

where K is Boltzman's constant, T is absolute temperature, I_e is emitter current, r_b is base resistance and q is electron charge. Figure 4 shows R_i as a function of collector current ($\cong$ emitter current), assuming r_b equals 200 ohms and β equals 50.

Referring to Figs. 4 and 1, for R_2 equal to 100,000 ohms, A, or 4,700 ohms, B, 90 percent of the small-signal current from the generator will flow into the transistor and 10 percent through R_3. Thus for higher collector currents than those corresponding to points A and B, the error in β will be less than 10 percent when taking δI_e as a measure of β, without any further corrections.

The use of a small-signal base-current frequency of 10 kc requires that the β frequency cutoff of the transistor be well above 10 kc. This condition is satisfied for transistors with an alpha-cutoff frequency in excess of 1 mc and of β smaller than 100 as $f_{\beta\alpha}$ equals $f_{\alpha\alpha}/\beta$ equals 10 kc.

The sweep generator has to have an output voltage of at least 94 v to produce an I_e sweep of 200 ma at a minimum d-c β of 10. The circuit of Fig. 2 provides 150 v.

The assistance of C. Jackson in building the power supplies and of F. Stottle for the general wiring of the equipment is acknowledged.

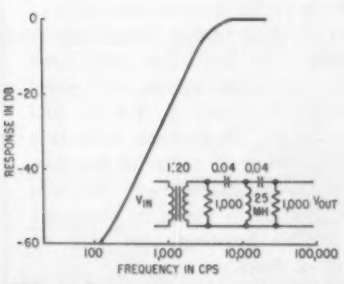


FIG. 3—High-pass filter and attenuation at V_{IN} equal to 10 mv

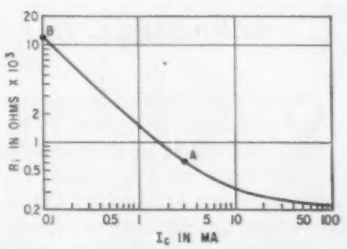
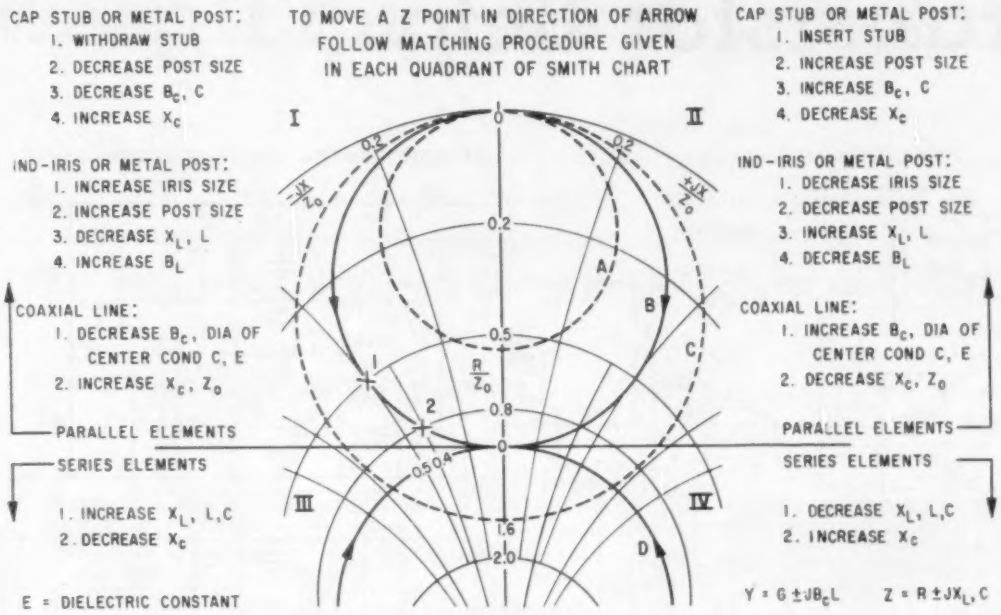


FIG. 4—Base input resistance as a function of collector current assuming r_b equals 200 ohms and β equals 50; A at R_2 equal to 100,000 and B at 4,700 ohms correspond to 10-percent error



Problems in uhf impedance matching are solved quickly using this Smith-chart guide that shows how transmission-line parameters change as matching-element dimensions are varied

Smith-Chart Guide

By MICHAEL C. LA BELLA, Airborne Instruments Lab., Mineola, N. Y.

QUICK ANSWERS to impedance-matching problems, when matching waveguide and coaxial components at microwave frequencies, are supplied by the accompanying Smith-chart guide.

Use the upper half to match parallel elements, the lower half to match series elements.

Circles *A*, *B* and *C*, tangent to each other at the top of the chart, are drawn duplicates of the existing family of constant-resistance circles tangent to each other at the bottom of the Smith chart. A variable reactance in parallel will move impedance points along these circles.

Points maneuvered about the chart will always be impedance rather than admittance points.

To match an impedance point to the center of the chart when using parallel elements, rotate the impedance point by use of a line transformer to the *B* circle. By varying the parameters as indicated in quadrants I or II the impedance point can be moved along the *B* circle in the direction of the arrows. For instance, when using a capacitive stub or metal post, reference to quadrant II under that heading shows that when the stub is inserted further into the waveguide, the increase of B_c or *C* causes the impedance point to move along the *B* circle towards the center.

For series matching, transform the impedance point to circle *D*. Then, to move the point along *D* in the direction of the arrows, vary the transmission line parameters as indicated in quadrants III or IV.

Example

An impedance point rotated through a line transformer appears as the normalized value of $0.5 - j0.5$ (point 1) on the *B* circle. An inductive iris, used for matching, moves this point along the circle to $0.8 - j0.4$ (point 2). To further move this point along *B*, towards the center of the chart, vary the size of the iris as given in quadrant I under heading IND IRIS OR METAL POST.

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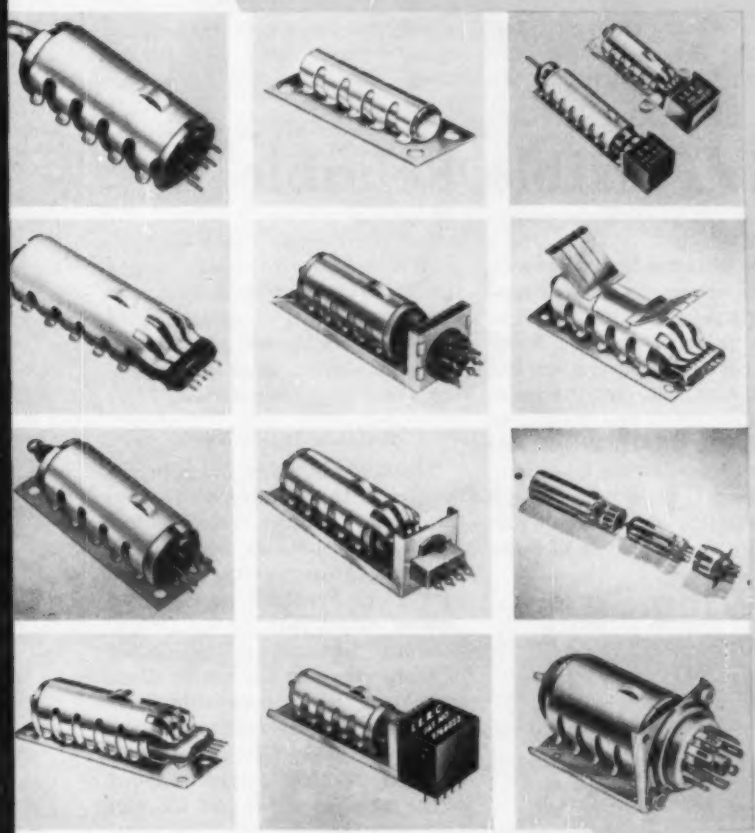

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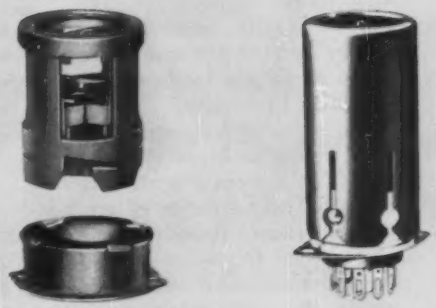

T5 and T6 TR5 and TR6

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MIL-S-242A (Ships)
MIL-S-19786A (Navy)
SCL-6307/2 (Signal Corps)

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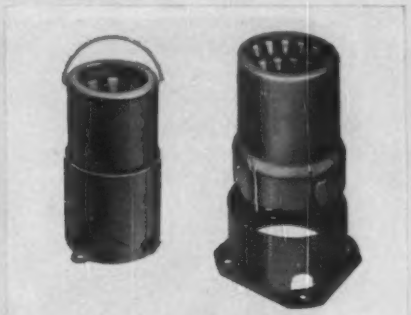

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Maser Supports Relativity Theory

EXPERIMENT recently completed gives strong further confirmation of Einstein's Special Theory of Relativity. The test was made possible by the maser.

The results were announced jointly by IBM's Watson Research Lab and the physics department of Columbia University.

Variation in frequency of radio waves from a beam of ammonia molecules were systematically measured over a period of one day. The experiment shows exactly what changes in frequency may occur when the stream of molecules travels in the same direction as the earth in its orbit and when it travels in the opposite direction.

Basic to Einstean's Special Theory of Relativity is that velocity of light is independent of its frame of reference or of motion of light source. There should be no change of light velocity, or r-f frequency, when the molecular beam source travels with the earth's orbital velocity or against it.

Early Experiments

Previous experiments, starting with the Michelson-Morley experiment in 1887, generally confirm Einstein's theory. However, these experiments have an accuracy that is considerably limited by the experimental methods used.

The results can be expressed in terms of the earth's velocity with respect to a fictitious ether, which, before Einstein's theory, was thought to pervade the universe. The present experiment using a maser shows that any velocity with respect to such an ether is 50 times less than the amount detectable by previous experiments.

The master measures molecular wave frequencies to one part in 10^{-10}. Accuracy results from maser's ability to count time intervals with a precision much greater than previous methods using physical distance.

Decade Counter Is Flexible, Reliable

EXCEPTIONAL reliability and versatility are claimed for a transistorized decade counter. The Packard Bell circuit was designed so as to reduce greatly the effects of environmental and supply-voltage changes.

The counters are capable of operating with input collector supply voltage varying from a low of 18 volts to a high of 55 volts, although 40 to 45 volts is suggested as an optimum range. Maximum counting rate is 40,000 cps.

Reliable operation is possible with either *pnp* or *npn* transistors having d-c beta gains varying from 6 to 18. Only polarity reversal is required in changing between *npn* and *pnp* transistors. The circuit was operated using 2N43 and 2N45 *pnp* types and 903, 2N117, 2N160 and 2N332 *npn* types. Other types may also be used.

The versatility of the circuit was achieved by the application of large signal techniques. The transistors and diodes are switched from a highly conducting state to a nonconducting state. Transistor gain and supply voltage may therefore be varied through a large range without affecting performance.

Bistable Multivibrator

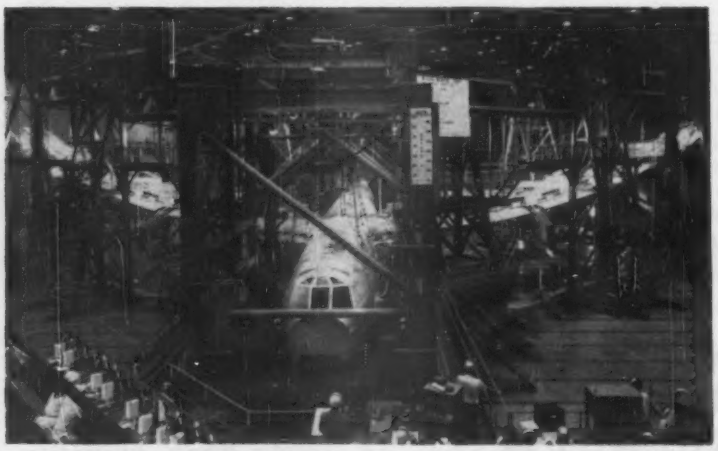
The basic building block in the counter is the bistable multivibrator, which produces binary counts. Increasing counts is achieved by cascading binary units, as shown in Fig. 1. Feedback provides the desired output rate.

Salient features are the method of triggering and the use of diode switching. When transistor Q_1 is conducting, collector voltage is reduced and diode CR_1 cannot conduct. A negative trigger applied at the cathodes of CR_1 and CR_2 can only pass through CR_2. The negative-going signal appears at the base of Q_1, cutting it off and switching the circuit to its other stable state with Q_2 conducting.

The diodes provide isolation if the applied trigger is no larger than the output signal of the binary counter. Output from one multivibrator triggers the next multivibrator.

Diodes CR_3 and CR_4 in the feedback circuit are cut off until tran-

Strain Gages Monitor Wing Stress



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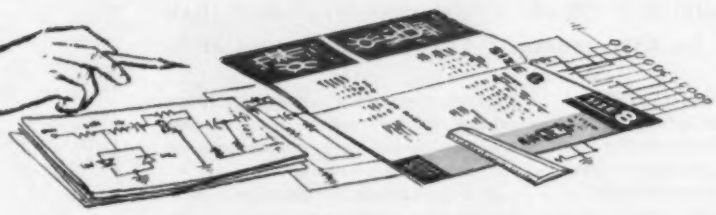

ACTUAL SIZE

SYNCHRO FUNCTION	CPPC TYPE	PRIMARY Input Voltage (400~)	PRIMARY Input Current (Amps.)	PRIMARY Input Power (Watts)	PRIMARY Output Voltage (Volts)	PRIMARY Sensitivity (MV/deg.)	PRIMARY Phase Shift (deg. lead)	D.C. RESISTANCE Rotor (Ohms)	D.C. RESISTANCE Stator (Ohms)	IMPEDENCE Zro (Ohms)	IMPEDENCE Zso (Ohms)	IMPEDENCE Zrs (Ohms)	Max. Null Voltage (MV)	ACCURACY Max. Error (Min.)
Torque Transmitter	CGC-8-A-7	26	.100	.54	11.8	206	8.5	37	12	54 + j260	12 + j45	80 + j20	30	7
Control Transformer	CTC-8-A-1	11.8	.087	.21	23.5	411	9	143	24	210 + j690	28 + j114	250 + j73	30	7
Control Transformer	CTC-8-A-4	11.8	.030	.073	22.5	393	8.5	365	64	470 + j1770	81 + j330	590 + j190	30	7
Torque Receiver	CRC-8-A-1	26	.100	.54	11.8	206	8.5	37	12	54 + j260	12 + j45	80 + j20	30	30 sp.
Electrical Resolver	CSC-8-A-1	26	.038	.39	10.8	189	20	230	27	270 + j630	39 + j142	340 + j67	30	7
Electrical Resolver	CSC-8-A-4	26	.038	.39	26	454	20	230	170	270 + j630	250 + j830	340 + j67	30	7
Control Differential	CDC-8-A-1	11.8	.087	.21	11.5	204	9	36	24	38 + j122	28 + j114	47 + j13	30	7
Vector Resolver	CVC-8-A-1	26	.100	.54	11.8	206	8.5	37	16.5	54 + j260	19 + j60	80 + j20	30	7

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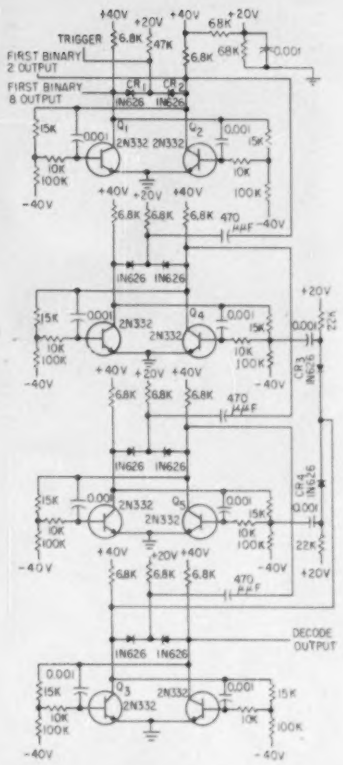

FIG. 1—Bistable multivibrators are cascaded to form decade counter that operates over wide range of operating voltages and temperatures

sistor Q_2 conducts. When the diodes conduct, the second and third binary count transistors, Q_4 and Q_6, are switched off, returning to their original state.

After the feedback operation, when the second binary counter receives its normal switching information, the state of the second, third and fourth binary counter is switched. This switching causes both sides of the diode switch to become more positive, returning the diodes to the nonconducting state.

Multivibrator Operates Relay

By G B. MILLER

British Thomson-Houston Co., Rugby, England

OPERATING a relay with a low-level control signal is a common requirement in electronic equipment. A sensitive and stable transistor-operated relay is described that can be operated by control signals in the

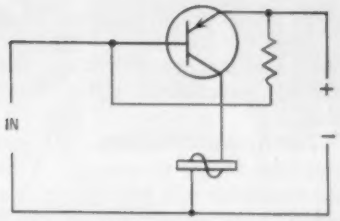

FIG. 1—Step-function voltage or current operates relay by causing transistor to saturate

frequency range from 50 cps to 500 kc, at temperatures up to 65 C and with signal-to-noise ratios as low as 2 to 1.

When the control signal is d-c, it is generally applied as a step-function voltage or current. The design of a workable circuit is comparatively simple.

Basic Relay Circuit

A basic d-c controlled transistor-operated circuit is shown in Fig. 1. The single transistor is normally biased to cutoff. A suitable step-function voltage or current is used to saturate it, allowing a large current to flow and operate the relay.

The circuit is simple and effective but requires that the step-function input have a reasonably small rise time and adequate amplitude if dissipation while switching is to be kept within safe limits.

In the case of a low-level a-c control signal with a poor signal-to-noise ratio, the design is more difficult and the circuit more complex. This is particularly so when transistors are used, since provision must be made for stability against temperature and transistor parameter variations.

The original circuit adapted for an a-c signal is shown in Fig. 2. The signal is rectified, and the output voltage or current is amplified by

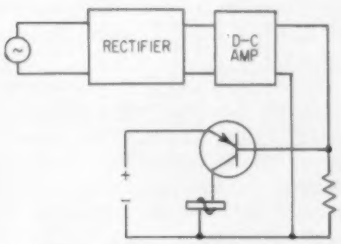

FIG. 2—Rectifier and d-c amplifier are required to operate basic relay circuit with an a-c signal

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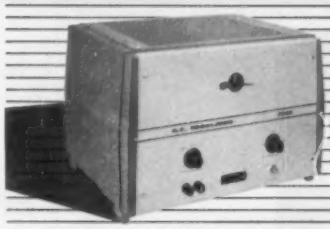
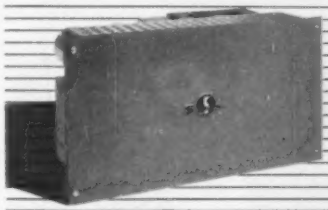


0.01% regulation—Why be half safe? You can get a-c line voltage regulation to the exact degree of precision you need from Sorensen. Model 2501 (left) regulates a-c line voltage to ±0.01% at 2500 VA. Other Sorensen a-c models range in precision from meter calibrators to rugged "constant voltage transformers," designed to give you maximum volt-amps per dollar.

Fully-transistorized regulated d-c supplies—The most complete line of transistorized low-voltage d-c power supplies on the market—like the new Model Q6-2 (left)—is offered by Sorensen. Regulation accuracy is ±0.25% (line and load combined). Life is exceptional. Response speed is extremely fast. They come with voltage adjustable over 2:1 range (Model Q Series) in 6, 12, 28 vdc and capacities to 200 watts. Also in 0-36, or 0-75 vdc continuously variable "Rangers" (Model QR Series) of 150-watt capacity.



Here's a d-c workhorse for rack-panel equipment—New Sorensen Model MD supplies feature magnetic regulation, semiconductor rectifiers, capacitance-input filters—and low cost. What's more you get any factory preset voltage you want, from 2.5 vdc to 1000 vdc. Available in 8 sizes from 25 to 3000 watts. No switches, no fuses (short circuited output is not recommended, but is not damaging). Ideal for powering your 19" rack-panel equipment.

Sorensen has many other ideas for packaging power to your needs, including standard off-the-shelf models, both electronic and transistorized, to take care of almost every need for controlled power—whether ac or dc, low or high voltage, low or high current. Ask for the latest Sorensen catalog. And let Sorensen engineers talk over with you a complete power system for your complex electronic equipment.

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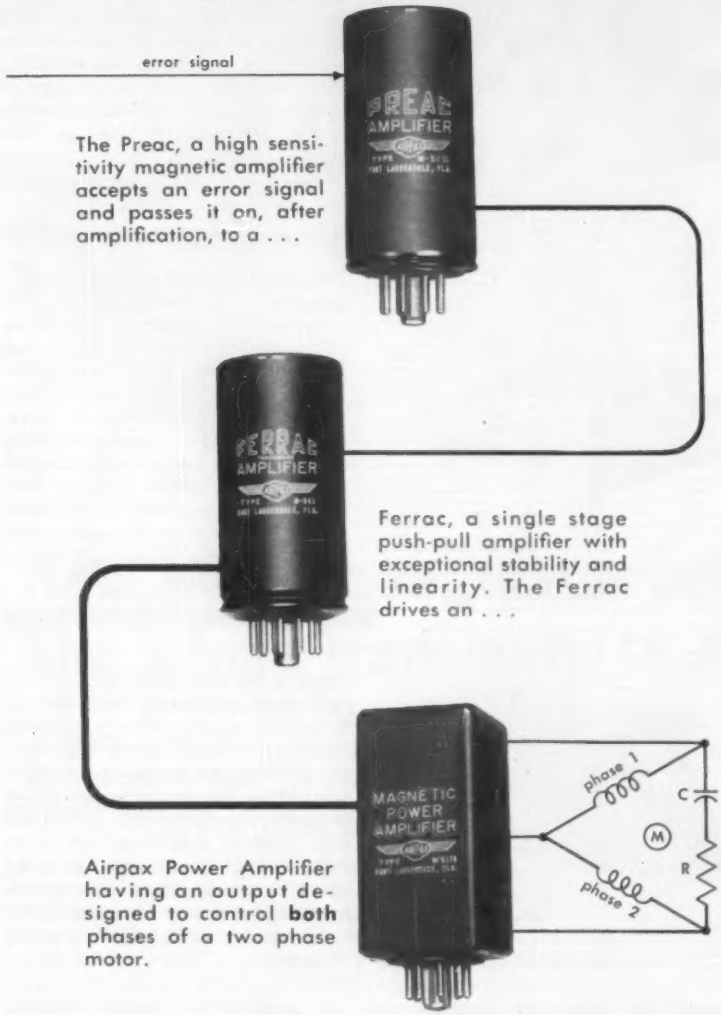
error signal
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the d-c amplifier and used to switch the transistor from cutoff to saturation.

The rectified voltage has poor rise time at low frequencies. Thus, the transistor will pass slowly from cutoff to saturation, giving rise to high dissipation during the transition period. If the input level is too low, the transistor might be kept in an unsaturated condition, which would damage it.

To overcome these problems, it is normal practice to operate the circuit with an input signal very much greater than is actually necessary. While this is not in itself harmful, it limits the circuit to applications where a high signal-to-noise ratio is available.

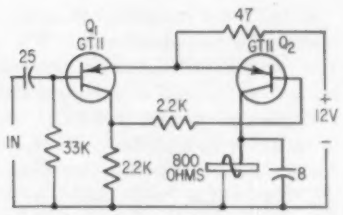

FIG. 3—Multivibrator-controlled relay is fast-switching, sensitive and stable

Ideally, a relay circuit should switch as rapidly with small signals as with large signals and should only operate with input signals greater than a predetermined level. In addition, it is desirable that the relay release immediately when the signal falls below this level.

Multivibrator Relay Control

It is possible to satisfy these requirements to a large extent by using the control signal to trigger a multivibrator. An emitter-coupled monostable multivibrator for use with a step-function voltage is shown in Fig. 3. Normally, Q_1 conducts and Q_2 is cutoff. The base bias of Q_1 is adjusted to ensure this condition.

If the base bias of Q_1 is decreased, collector current is reduced and collector voltage rises. This rise appears at the base of Q_2. When the bias of Q_1 has been reduced sufficiently, Q_2 conducts, switching the multivibrator.

This condition is maintained until bias on Q_1 is restored to normal. At this time, the circuit im-

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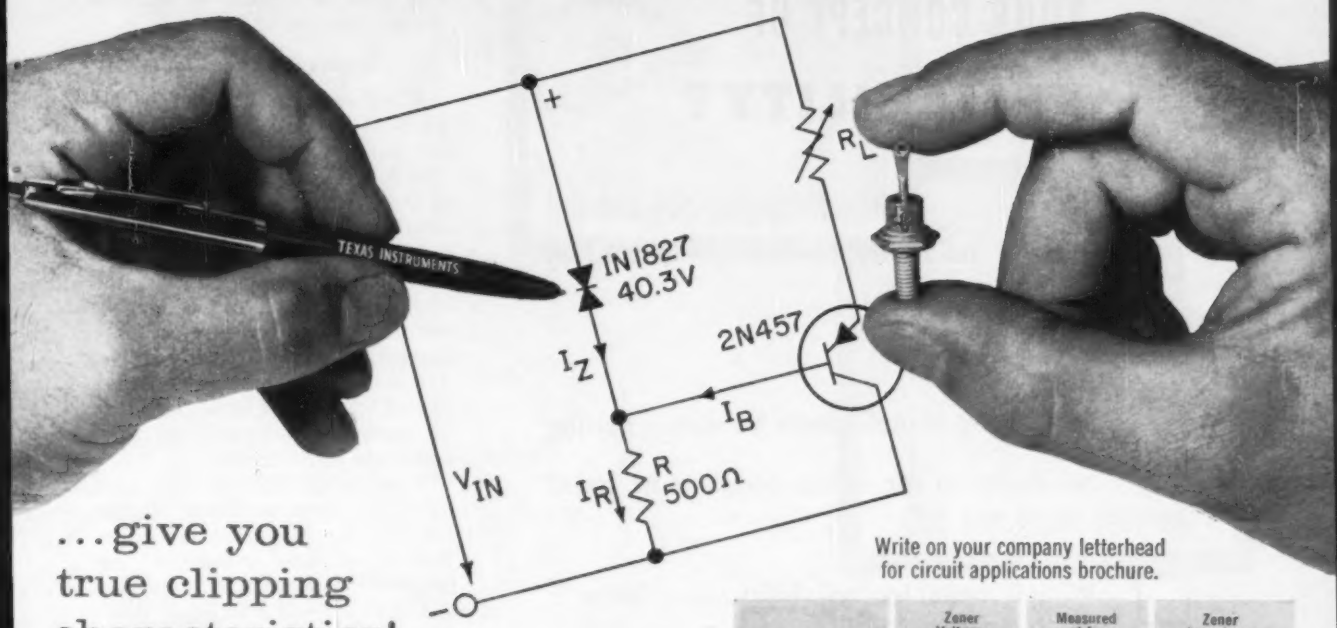

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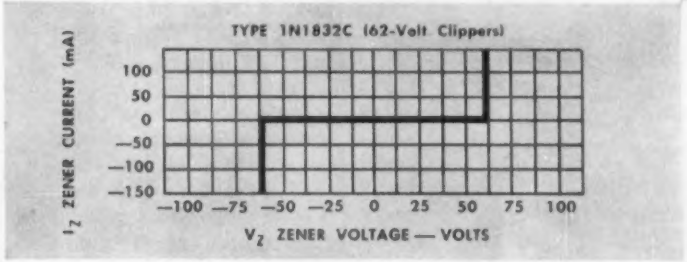
Write on your company letterhead for circuit applications brochure.

Type	Zener Voltage V_Z Volts	Measured at I_Z I_Z mA	Zener Impedance at I_Z Z_Z (max) ohms
1N1816	13	500	2
1N1817	15	500	2
1N1818	16	500	3
1N1819	18	500	3
1N1820	20	250	3
1N1821	22	250	3
1N1822	24	250	3
1N1823	27	250	3
1N1824	30	250	4
1N1825	33	150	4
1N1826	36	150	5
1N1827	39	150	5
1N1828	43	150	6
1N1829	47	150	7
1N1830	51	150	8
1N1831	56	150	9
1N1832	62	50	12
1N1833	68	50	14
1N1834	75	50	20
1N1835	82	50	22
1N1836	91	50	35



1N1816C — 1N1836C CLIPPER

Types 1N1816C — 1N1836C are specifically designed to clip, and exhibit true double anode characteristics. Each zener is held within 10% tolerance of the specified voltage. See "Typical Clipper Characteristics" curve at left.

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- ☐ How did one manufacturer get twice the capacity in a solid tantalum capacitor without increasing the case size?

The answers to these questions will be found on the next three pages in the Fansteel Advertisements.

X582A

mediately switches back to its stable condition. Thus, a step-function voltage that reduces bias of Q_1 causes fast switching to Q_2; or, if a long pulse is applied, Q_2 operates for the duration of the pulse.

Modes of Operation

When switching the multivibrator with an a-c signal, the circuit can have two modes of operation. The first occurs when a-c applied to Q_1 has a peak value greater than minimum trigger voltage. During some portion of every half cycle that decreases base current, the circuit will be triggered. During the half cycles that increase base current, the circuit remains stable. Transistor Q_2 is therefore switched on and off once per cycle. Duration of the on state depends on peak amplitude and frequency.

When a-c applied to Q_1 has a peak value less than minimum trigger voltage, the second mode occurs. With Q_1 saturated or nearly so, the transistor operates as an integrator and can generate a staircase function at its collector. This causes collector voltage of Q_1 to be reduced in small steps until Q_2 starts conducting, triggering the circuit. Duration of this state is principally a function of natural frequency of the multivibrator and is largely unrelated to frequency of the applied signal. Waveforms under these conditions are shown in Fig. 4.

A relay in the collector of Q_2

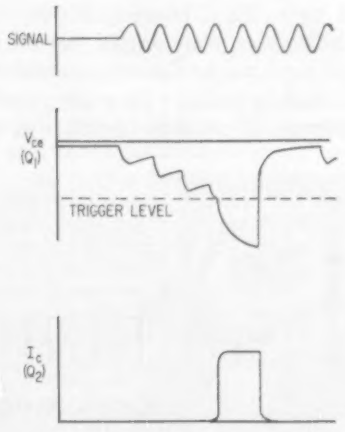

FIG. 4—Normally conducting transistor acts as integrator when a-c peak input is less than trigger level. Multivibrator is triggered when accumulated collector voltage goes below trigger level

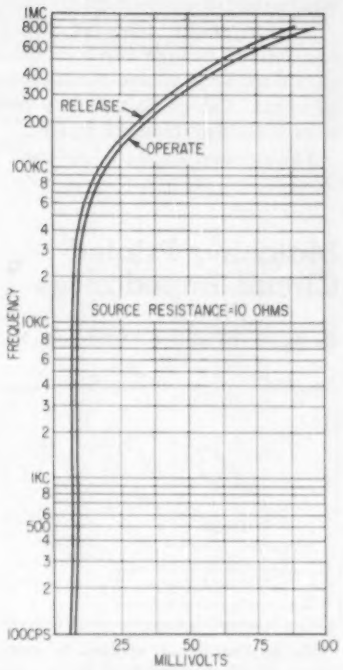

FIG. 5—Voltage levels for opening and closing relay are shown as a function of frequency

receives a succession of current pulses when an a-c signal is applied to Q_1. This causes the relay to chatter. In addition, high voltages that can damage the transistor are generated at the collector because of the highly inductive load.

Both chatter and voltage surges can be eliminated by shunting the relay with a diode or a large capacitor. The diode is superior in that the dissipation during the switching period is kept at a minimum. The capacitor is more effective in preventing relay chatter. However, it increases dissipation of the transistor during switching.

The 2,200-ohm resistor between collector of Q_1 and base of Q_2 isolates the collector from large changes in input resistance of Q_2. The input capacitor for Q_1 should have negligible reactance at the lowest operating frequency. Lowest base bias resistance for Q_1 is chosen to keep Q_1 conducting and Q_2 cutoff.

Sensitivity is primarily determined by the source resistance of the control signal. For maximum sensitivity, this should be as low as 10 ohms. Where the operating level must be controlled, a 1,000-ohm adjustable resistance in series with

Like a chain with one weak link, the malfunction of a single component in today's complex electronic gear means an aberration ranging from "slight" to "catastrophic." That's why, in much of today's equipment, particularly in military gear, *component reliability* takes precedence over all other considerations.

It is towards this goal of absolute reliability that Fansteel Silicon Rectifiers are engineered and produced. To achieve Fansteel's "Reliability Safety Factor" no check, no test and no precaution is omitted. If your product cannot tolerate component failure, Fansteel Silicon Rectifiers are your logical choice.

Write for Bulletin 6.302

The new Fansteel 1N1600 series Silicon Rectifiers are conclusive evidence that it's possible to get subminiaturization without affecting reliability. Fansteel's unfailing reliability has been built into this smallest of silicon rectifiers rated at 750 milliamperes with a peak reverse voltage range of 50-600 volts, and an operating temperature range up to 165°C.

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As with all Fansteel Tantalum Capacitors, the Blu-Cap more than meets today's demands for high reliability.

You can get all the details about today's biggest value in tantalum capacitors in our new Bulletin 6.120.

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the signal source will allow a very wide range of adjustment.

Fig. 5 shows required operate and release voltage for frequencies to one mc with source resistance of 10 ohms. Values do not vary more than 5 percent from 25 to 65 C.

Thanks are due P. J. Billing.

Matching Printed Circuit Impedances

By L. N. MERSON *Philadelphia, Pa.*

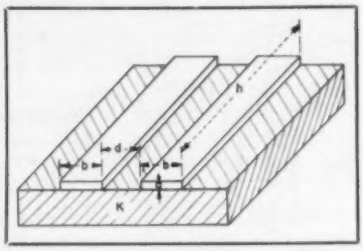


FIG. 1—Dimensions applied in equations permit calculation of Z

IN CONNECTING printed circuits to transmission lines, there may be excessive reflection at the connection unless printed conductors have the same characteristics as the line. The following formulas have been developed for calculating characteristic impedance of printed-wiring transmission lines.

The characteristic impedance of any two-conductor system is approximately

$$Z = \sqrt{L/C}$$

where L and C are usually expressed per unit length of line.

$$L = 0.0234 \log_{10}\left(\frac{d+b}{a+b}\right) + 0.01525 - 0.01016\left(m + \frac{d+b}{h}\right) \mu h$$

per inch, where dimensions are shown in Fig. 1 and values for m are given in Table I. In some cases m may be negligible, and $d + b/h$ can be neglected if the line is long compared to $d + b$.

$$C = 0.31\frac{a}{d} + 0.23\,(1+K)\log_{10}\left(1 + \frac{2b}{d} + 2\sqrt{\frac{b}{d} + \frac{b^2}{d^2}}\right) \mu\mu f$$

per in., where K is the dielectric constant of the base material.

Approximate formula for C was derived from field theory and multiplied by a correction fac-

TABLE I—Parameters for Calculating Printed-Circuit Impedance

$\frac{b}{b+d}$	m
0	0
0.05	0.0002
0.10	0.0008
0.15	0.0019
0.20	0.0034
0.25	0.0053
0.30	0.0076
0.35	0.0105
0.40	0.0138
0.45	0.0176
0.50	0.0220
0.55	0.0269
0.60	0.0325
0.65	0.0388
0.70	0.0458
0.75	0.0536
0.80	0.0625
0.85	0.0725
0.90	0.0839
0.95	0.0973
1.00	0.1137

tor of 1.4 to account for fringing effects. Results agreed satisfactorily with experimental measurements. Characteristic impedance can be lowered by increasing strap width, decreasing spacing, and/or increasing dielectric constant.

Suppose a long line of 2 oz. copper foil ($a = 0.0027$ in.) is printed on XXXP bakelite ($K = 4.3$ at 10^6 cps) with conductor widths

$b = 1/16$ in. and spacing d = 1/16 in.

$$C = 0.31 \times \frac{0.0027}{0.0625} + 0.23\,(1 + 4.3)$$

$$= 0.0134 + 0.23\,(5.3)\,(0.765) = 0.95 \ \mu\mu f \text{ per inch}$$

$$L = 0.0234 \log_{10}\left(\frac{0.125}{0.065}\right) + 0.01525 - 0.01016\,(0.022)$$

$$= 0.00665 + 0.01525 - 0.00022 = 0.0217 \ \mu h \text{ per inch}$$

$$Z = \sqrt{\frac{L}{C}} = \sqrt{\frac{0.0217 \times 10^{-6}}{0.95 \times 10^{-12}}} = 151 \text{ ohms}$$

Suppose the width is increased to $b = \frac{1}{8}$ in. and the separation decreased to $d = \frac{1}{32}$ in.

$$C = 0.0268 + 0.023\,(5.3) \log_{10}(1 + 8 + 2\sqrt{4 + 16})$$

$$= 0.0268 + 0.23\,(5.3) \log_{10}(17.95) = 1.56 \ \mu\mu f \text{ per inch}$$

$$L = 0.0234 \log_{10}\left(\frac{0.154}{0.125}\right) + 0.01525 - 0.01016\,(0.0625)$$

$$= 0.00210 + 0.01525 - 0.000635 = 0.0167 \ \mu h \text{ per inch}$$

$$Z = \sqrt{\frac{0.0167 \times 10^{-6}}{1.56 \times 10^{-12}}} = 103 \text{ ohms}$$

The New Fansteel Solid Tantalum

STA CAPACITORS GIVE DOUBLE THE RATING IN THE SAME CASE SIZE

This newest development in solid tantalum capacitors is available in ranges of 6 to 60 volts (wvdc) . . . capacity ranges of .0047 to 330 mfd . . . unsurpassed stability over an operating temperature range of −55°C. to +125°C. . . . with extremely low leakage.

125°C

The new STA is another step by Fansteel to provide a *complete* range of solid tantalum capacitors that have been designed to meet the ever-increasing demands for greater capacity in sub-miniature sizes.

And as with all Fansteel Products, unfailing reliability is assured. Our new Bulletin 6.112 tells why.

FANSTEEL RELIABILITY

C5813A

FANSTEEL METALLURGICAL CORPORATION North Chicago, Ill., U. S. A.

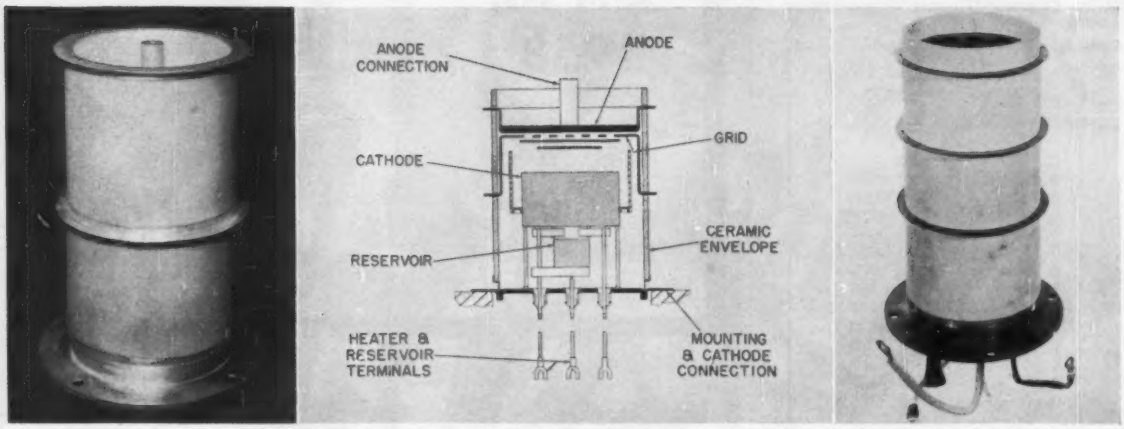


FIG. 1—Developmental ceramic hydrogen thyratron, type Z-5069 (left). Cross-sectional view of Z-5069 (center). Developmental Z-5101 with one gradient grid (right)

High-Power Ceramic Thyratrons

MOST HIGH-POWER radar equipments use hydrogen thyratrons as switching tubes in line-type pulsers. A lumped-constant delay line is charged to a high voltage. It is then discharged by firing the thyratron which, in turn, provides pulses of power to the r-f oscillator.

Tube requirements for such radars are toward higher peak and average power levels. Former designs in hydrogen thyratrons do not lend themselves to great extension in power levels. But in a paper presented before a recent AIEE meeting, H. N. Price and A. W. Coolidge of General Electric described their company's development of ceramic hydrogen thyratrons with external anode and grid elements capable of handling the required powers.

Developmental Tubes

At the left in Fig. 1 the Z-5069 developmental tube is illustrated and, immediately to its right, a cross-sectional view is shown. The tube is about five in. in diam and 10 in. tall. Power ratings are 33 megawatts peak and 66 kw average. Both anode and grid consist of cups with extended flanges brazed directly to the ceramic cylinders which form the envelope and provide the insulation between elements. The cathode is supported from a header brazed into the bottom of the ceramic envelope.

Because the anode is external to the tube and is convection-cooled rather than radiation cooled, the lower end of the reservoir range of the tube is extended at high average power levels. It is an order of magnitude greater than in internal-anode tubes. For still greater heat dissipation, forced-liquid cooling can be used.

Grid Cooling

Grid cooling is provided by the external flange and its connection to the envelope. Less heat is radiated to it from the relatively cool anode. The simple planar construction in the anode-grid area gives improved high-voltage operation. Ion formation is low because of close spacings between cylindrical surfaces of the anode and grid and corresponding ceramic surfaces.

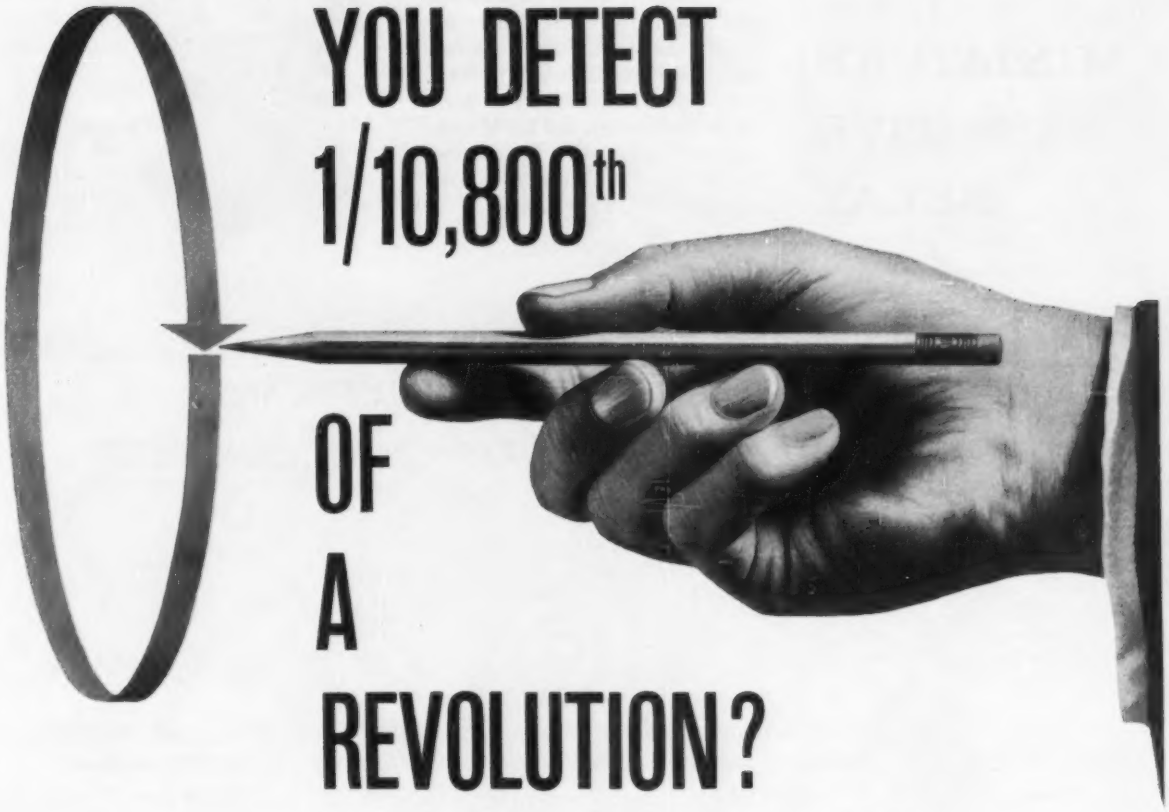
Objective ratings for ceramic thyratrons under development are shown in Table I. The Z-5069 is designed for peak power levels within the range of existing tubes but for twice the average power. The Z-5101 and Z-5212 are two developments for larger sizes in terms of both peak and average power.

The Z-5101 has been operated successfully at peak anode voltages to 50 kv while switching a peak output power level of 75 megawatts. This performance and that at higher voltage levels is facilitated by use of voltage-dividing or gradient grids. Anode voltage is divided between tube sections

Table I—Objective Ratings for New Ceramic Hydrogen Thyratrons

	Z-5069	Phase I Z-5101	Phase II Z-5212	Phase III
Peak forward volts (kv)	33	40	50	100
Peak current (amps)	2,000	2,400	2,000	2,000
Average current (amps)	4	2.2	8	8
Average power out (kw)	66	44	200	400
Peak power out (kw)	33×10^3	48×10^3	50×10^3	100×10^3
Anode dissipation factor (Peak voltage x peak current x prr)	40×10^6	45×10^6	400×10^6	800×10^6

COULD YOU DETECT 1/10,800th OF A REVOLUTION?



Detecting microscopic shaft movement of as little as 2 minutes —well beyond the ability of most standard synchro units— can now be accomplished with new synchros designed and produced by Ketay, and available for immediate delivery. Such increased accuracy, three times better than the highest Mil Spec requirements, is the result of Ketay design and production competence.

Ketay has also developed a complete line of improved thru-bore synchros to the new Mil Spec 20708 (supersedes Mil Spec 16892). These improved units are available at no increase in cost in a full line of control and torque types, with frame sizes from 08 to 23. Thru-bore construction and stainless steel housing make them more rugged and more reliable as well as providing better accuracy and greater stability. *Ketay is the only approved Bureau of Ordnance source currently manufacturing and shipping all these units.*

Ketay research and development engineers are regularly working on advanced new components and prototype control system problems for the armed forces and leaders in the aircraft and missile industry. Let them help solve your special problems in component performance and environment adaptability.

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RESOLVERS
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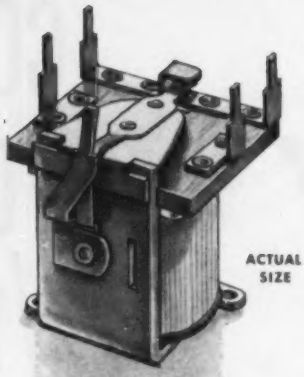
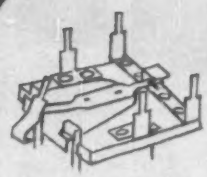
MINIATURE SENSITIVE RELAY

Millions of Type MS relays now in extensive use in highly competitive markets—automotive, radio, and television. Proven ideal for applications requiring a sensitive, highly reliable single pole or common multiple contact DC unit. Mass production, and RBM's experience in assembly techniques, make Type MS your *low cost* solution for volume usage.

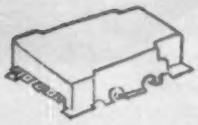


ACTUAL SIZE

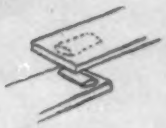
BUILT TO WITHSTAND EXTREME ENVIRONMENTAL CONDITIONS AT **LOW COST**



AVAILABLE WITH PRINTED CIRCUIT TERMINALS



ENCLOSED CONTACTS WHERE DESIRABLE



X-BAR CONTACTS INSURE MAXIMUM RELIABILITY

NO CURRENT-CARRYING RIVETS

COIL CONSTRUCTION MEETS UNUSUAL CLIMATIC CONDITIONS

CHARACTERISTICS

	MS-40	MS-25
COIL RESISTANCE	TO 10,000 OHMS	TO 15,000 OHMS
MAX. COIL POWER	1 WATT	1.5 WATT
MIN. COIL POWER	.40 WATT (SINGLE POLE)	.025 WATT (SINGLE POLE)
CONTACT RATING	1 AMP. 28V D.C. OR 115V A.C. (NON-INDUCTIVE)	1 AMP. 28V D.C. OR 115V A.C. (NON-INDUCTIVE)

CONTACT FORMS

SINGLE POLE	COMMON MAKE
NO	3NO & 1DT
NC	5NO
DT	

TERMINALS

(A) SOLDER TYPE - ALL VERSIONS

(B) PRINTED CIRCUIT TYPE (SINGLE POLE VERSIONS ONLY)

Consult your local RBM Product Application Engineer or write for Bulletin MS-3

RBM Controls Division

ESSEX WIRE CORPORATION, LOGANSPORT, INDIANA

formed by means of external circuitry or simply by the capacitance between the elements. A Z-5101 with one voltage-dividing grid (two sections) as well as the usual control grid is shown at the far right in Fig. 1.

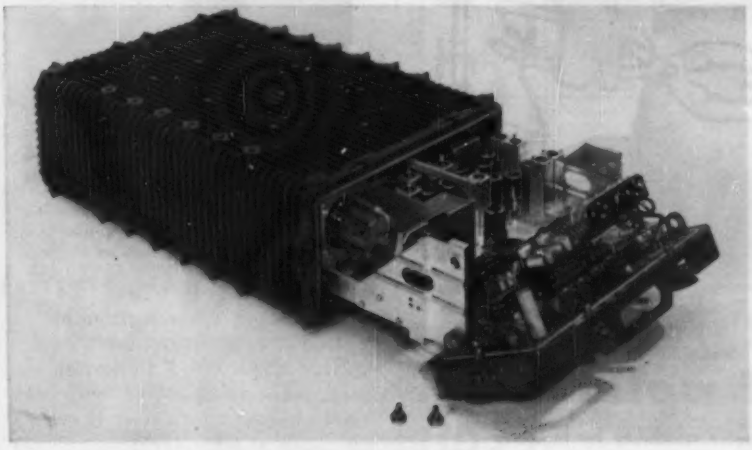
Future Problems

Anode dissipation becomes a problem as tube ratings increase. Sizeable increases in anode size have doubtful value since this technique probably will result in decreased utilization of the total area of both anode and grid. Further power-level increases most likely will require forced-liquid cooling.

As power levels are raised, hydrogen clean-up becomes increasingly severe. Use of larger reservoirs, maintenance of tube pressure by a regulating means employing a reservoir and a monitoring device or possibly a solution of the basic problem must be found.

Major portion of the development work on the tubes was supported by the Armed Services under Air Force and Signal Corps contracts.

Hermetically Sealed Mobile Gear



TO IMPROVE RELIABILITY and extend usage to adverse conditions, N. V. Philips' Telecommunicatie Industrie of the Netherlands have in production a line of mobile equipment hermetically enclosed in diecast silumin cabinets.

Precision diecasting insures a close fit between the cabinet proper and the front panel on which the chassis is mounted. The hermetic seal is formed by an inlaid rubber gasket. Electrical connections are made by watertight plugs.

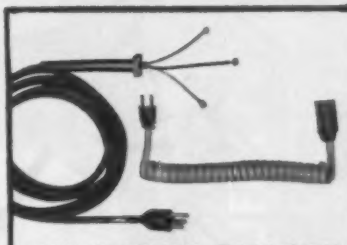
An interchangeable cartridge containing a moisture absorbent is installed through the front panel with visual saturation indication at the outside. These features enable the set to be serviced by the user. The cabinet has been designed with integral fins to remove heat.

Motor Operates at 950 F

NEW CONCEPTS in electrical insulation developed at Westinghouse Electric Corp. have made possible an electric motor that will operate continuously at 950 F for 100 hours. Operation at the high temperature for 1,000 hours has been accomplished by placing the motor bearings outside the oven in which the rest of the motor is placed and cooling them with forced air.

Four basic insulation components of the motor are: phase insulation, slot insulation, wire insulation and potting and impregnating compound. Phase and slot insulation is flexible sheet material consisting of glass cloth and large mica flakes bonded with phosphate. Wire is insulated by covering it with

They can be your design assistants on other Essex Engineered Products.



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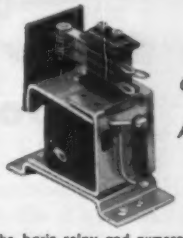
Cords Limited Division, DeKalb, Ill.



GENERAL PURPOSE RELAY

The basic relay and numerous contact forms, ratings and terminals variations are regular production items...have been "customerized" to solve almost every conceivable problem. Such versatility permits engineering short-cuts that lower your "back door" cost.

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Wire and Cable Div., Ft. Wayne, Ind.

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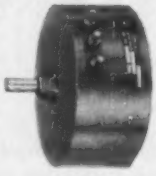
...and now for a spot of welding!

Still at it? Trying to improve potentiometer reliability by building 'em yourself? Well, you're on the right track about *one* thing — welding's a sure way to eliminate a lot of operational headaches — like gassing contamination of contact metals at high temperature, from organic solder flux. No chance of "cold joints", either, to increase circuit resistance. No soldered connections to come loose under vibration and shock. Welding *is* the way to reliability!

But why set the wife's drapes afire to get a reliable, all-welded pot? Utilizing welding techniques, Ace produces reliable potentiometers operable at temperatures exceeding 150°C. and able to withstand 50 G's at 2000 cycles. All this, plus extremely low contact resistance and longer rated life. All taps, end connections, resistance elements, contact assemblies and terminal leads are specially prepared beforehand — then welded with pure nickel or palladium silver. So, for built-in reliability through sounder construction techniques, see your ACErep!



This 2" AIA Acepot® (shown ½-scale) incorporates all these exclusive welding construction features, for superior reliability.

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glass fiber and then impregnating it with a suspension of powdered mica in a phosphate solution. After winding, the motor is impregnated and potted with a liquid slurry consisting of a phosphate solution, Wollastonite, silica and other chemically reactive materials.

Demonstration shows motor operating in heat from jets of burning gas still able to do useful work such as a grinding job

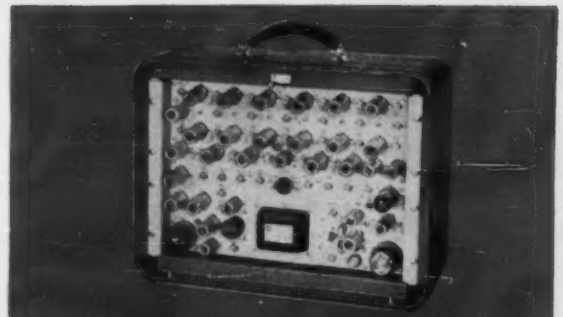
The potted motor is dried out to remove free moisture and then pyrolyzed above 600 F to develop the best properties. Silver wire was used for conductors since it resists oxidation at temperatures in excess of 1,000 F.

Monolithic-Structure Ceramic Capacitors

TWO GROUPS of monolithic ceramic capacitors have been developed by Sprague Electric Co., North Adams, Mass. One group uses high-dielectric-constant material for bypass and coupling applications. The other utilizes low-dielectric-constant material for resonant circuits and other applications requiring high stability. Both types were described in a WESCON paper by J. H. Fabricius and A. G. Olsen. The monolithic structure results in a capacitance gain of between 25 and 40 for a given volume compared to conventional construction techniques.

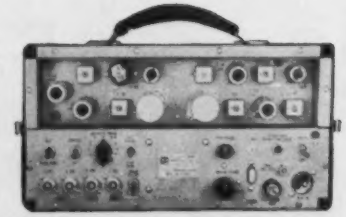
Basic Construction

Basic construction for both capacitors is shown in Fig. 1. For



1003-C VIDEO TRANSMISSION TEST SIGNAL GENERATOR

Produces multi-frequency burst, stairstep, modulated stairstep, white window, composite sync. Variable duty cycle. Regulated power supply.



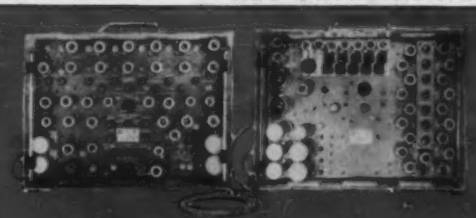
1004-B VIDEO TRANSMISSION TEST SIGNAL RECEIVER

Very rapid and accurate measurements of differential phase and differential gain characteristics of video facilities. Responds to standard stairstep test signal modulated with 3.58 mc.

VIDEO TRANSMISSION TEST EQUIPMENT

In Daily Use by Major Networks, Stations, and Long Lines Carriers

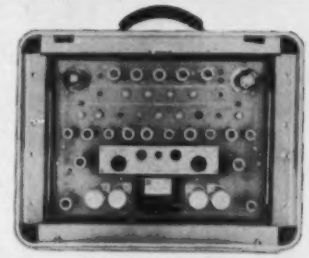
ALL UNITS AVAILABLE IN CARRYING CASE OR 12¼" STANDARD RACK MOUNTING



1005-A VIDEO TRANSMISSION TEST SET

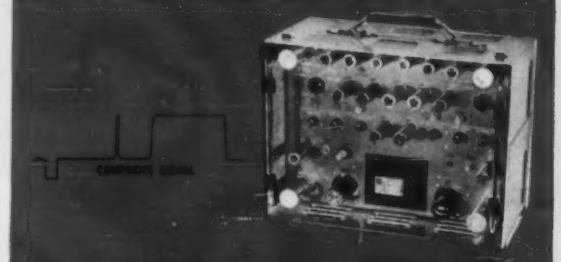
1005-A1 — Produces composite television waveforms suitable for measuring amplitude vs. frequency; differential gain vs. amplitude; dynamic linearity; differential phase vs. amplitude; high frequency transient response; low frequency transient response; low frequency phase or streaking; smears, mismatches; and other video characteristics.

1005-A2 — Supplies composite EIA Sync, blanking, horizontal and vertical drive signals and regulated B + power for itself and 1005-A1. Features magnetic core binary counters.



1008-A VERTICAL INTERVAL KEYER

Permits test and control signals to be transmitted simultaneously with program material, between frames of TV picture. Any test signal (multiburst, stairstep, color bar, etc.) may be added to the composite program signal. Test signals are always present for checking transmission conditions without impairing picture quality. The home viewer is not aware of their presence.



1073-CR Sin^2—SQUARE WAVE GENERATOR

Produces new waveform for testing TV or other pulse unit or system for amplitude and phase characteristics. Sin^2—Square Wave pulse is equivalent to TV camera signal and is more sensitive than a Square Wave in indicating ringing. Video test signal adjustable for 1.0 volts or 1.4 volts peak to peak. Now in use by major TV networks and long lines carriers.

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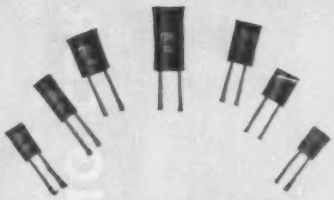

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To meet the requirements for printed circuitry, RPC has developed Type P Encapsulated Wire Wound Precision Resistors. Miniature, single ended units designed for easy rapid mounting on printed circuit panels with no support other than the wire leads. Many newly developed techniques are employed in the manufacture of Type P Resistors. These units can be operated in ambient temperatures up to 125°C. and will withstand all applicable tests of MIL-R-93B. Available in 7 sizes, rated from 1/10 watt to .4 watt. ¼" diameter by 5/16" long to ⅜" diameter by ¾" long. Resistance values to 2 megohms. Tolerances from 1% to 0.05%.

High Frequency Resistors

Used where requirements call for very low inductance and skin effect in circuits involving pulses and steep wave fronts. Depending on size and resistance value, these resistors are usable at frequencies to over 400 mc. Resistance values range from 20 ohms to 100 megohms with tolerance of 20% to 5%. 2 types available.
TYPE F resistors (shown) in 10 sizes from 9/16" long x 0.10" diameter to 6½" long x 9/16" diameter, with lugs or wire leads. Power ratings ¼ to 10 watts.
TYPE G resistors (not shown), in 6 sizes up to 18½" long. Power ratings 10 to 100 watts.

Encapsulated Precision Wire Wound Resistors

RPC Type L Encapsulated Resistors will withstand temperature and humidity cycling, salt water immersion and extremes of altitude, humidity, corrosion and shock without electrical or mechanical deterioration. Type L resistors are available in many sizes and styles ranging from sub-miniature to standard with lug terminals, axial or radial wire leads. Available for operation at 105° C. or 125° C. ambient temperatures. These resistors will meet all applicable requirements of MIL-R-93B, and Amdt. MIL-R-9444. Type L can be furnished with all resistance alloys and resistance tolerances from 1% to .02%.

High Voltage Resistors

Type B Resistors are stable compact units for use up to 40 KV. These resistors are used for VT voltmeter multipliers, high resistance voltage dividers, bleeders, high resistance standards and in radiation equipment. They can be furnished in resistance to 100,000 megohms. Available as tapped resistors and matched pairs. Sizes range from a ½ watt resistor ¾ inch long x ¼ inch diameter rated at 2500 volts, to a 10 watt resistor 6½ inches long x 9/16 inch diameter rated at 40 KV. Low temperature and voltage coefficients. Standard resistance tolerance 15%. Tolerances of 10%, 5% and 3% available. Tolerance of 2% available in matched pairs.

RPC resistors are noted for quality, performance and delivery as per schedule. Of necessity, this requires high skills in engineering and modern production facilities. In addition, RPC's test equipment and standards for calibrating and checking are on a par with the nation's outstanding laboratories. As a result, RPC is a steady supplier to many industrial companies, government agencies and the armed forces.

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Specializing in Manufacture of Resistors

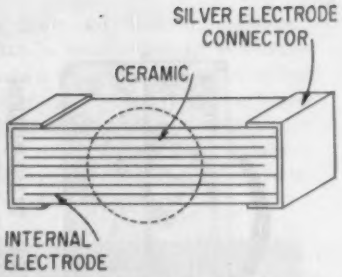

FIG. 1—Basic construction for new monolithic ceramic capacitors

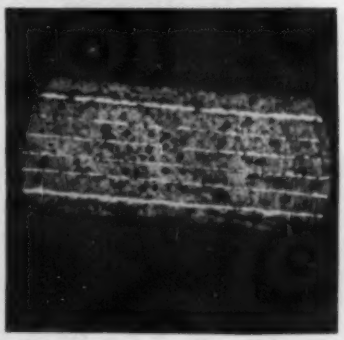

FIG. 2—Photomicrograph of section enclosed by dotted line in Fig. 1

the high-dielectric-constant unit, $BaTiO_3$ was used. In the original version shown in Fig. 1, five active dielectrics each 0.0025-in. thick occupy a volume of 0.620 by 0.355 by 0.018 in. Total capacitance is 0.4 μf. The dotted line in Fig. 1 encloses the area which is shown in the photomicrograph of Fig. 2.

High Stability Units

In low-temperature-coefficient capacitors the same basic electrode structure shown in Fig. 1 is used. A formulation of zero-temperature-coefficient (NPO material suitable for spraying was developed. This basic material has been accepted by the electronics industry for some time as inherently the most stable material for capacitors in large but practical geometries. Use of the specially developed spray version made possible the desired size reduction in the new monolithic construction.

As a result of the developmental program, capacitors with ratios of capacitance to volume as high as 0.58 μf/in.³ for high-stability dielectric material or 85 μf/in.³ for high-dielectric-constant material have been manufactured successfully.

...the record tells you more

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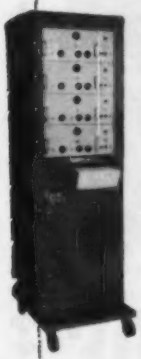
Permits convenient, variable speed editing and study of Sanborn charts and other types up to 16" wide, 200 ft. long. Single control for direction, paper speeds (15" to 100"/min). Transparent cursor slides left or right, adjusts for accurate alignment with coordinates.

1- TO 8-CHANNELS, 12 PLUG-IN PREAMPLIFIERS

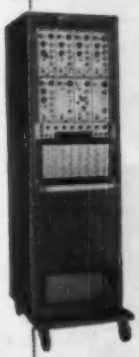
150 SERIES



Features of the "150 series" direct writers include: frequency response to 100 cps; linearity 1% overall; inkless recording in true rectangular coordinates by heated stylus on plastic coated Permapaper charts; current feedback driver amplifier and regulated power supply for each channel. Recorder has 9 chart speeds, 0.25 to 100 mm/sec; individual stylus heat controls, time-code marker. Up to 6-channels can be housed in one vertical cabinet. Amplifiers, recorder also available in individual portable cases.

6-, 8-CHANNELS, FLUSH FRONT RECORDER, FREQUENCY RESPONSE TO 120 CPS

350 SERIES



New "350" series direct writers with compact plug-in preamps in modules of up to 4; individual power supplies; current feedback transistorized power amplifiers; limiter circuit ahead of power amplifiers; velocity feedback galvanometer damping; enclosed galvanometers. Linearity 0.2 div. over entire 50 divisions. Recorder-power amplifier-power supply package has 0.1 volt/div. sensitivity, can be used separately; pushbutton controls for 9 chart speeds 0.25 to 100 mm/sec; individual stylus heat controls; contacts for remote control; inkless rectangular coordinate recording on Permapaper charts.

6-, 8-CHANNELS

850 SERIES

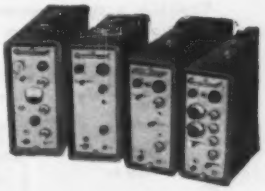
Compact "850" series direct writers use 7" high plug-in preamplifiers in modules of up to eight and "350" flush front recorder package with transistorized power amplifiers, power supply; features velocity feedback galvanometer damping; linearity 0.2 div. over entire 50 divisions; 9 chart speeds from 0.25 to 100 mm/sec controlled by electric pushbuttons; inkless recordings on Permapaper charts. Available preamps include Servo Monitor (demodulator) and DC Coupling. Carrier, Chopper Stabilized and Low Level types are in development.

COMPUTER READOUT . . . AUTOMATIC PROGRAMMING

150 SERIES

"150 series" 6-, 8-channel consoles in 46½" high mobile cabinet. Dual-Channel Amplifiers have selectable sensitivity from 0.01 to 10 volts/div.; internal calibration 2 volts ±1% freq. response flat to 20 cps. Optional Programmer sequences system operation in 20 steps, including recorder turn-on, calibration, computer DC level reading, recording for pre-set time, turn-off and reset.

SELF-CONTAINED UNIT PREAMPLIFIERS TO DRIVE 'SCOPES, OPTICAL OSCILLOGRAPHS, TAPE RECORDERS, ETC.



Portable "350" series include Carrier, DC Coupling Servo Monitor (demodulator), True Differential DC types; others in development. Mount in portable "450" cases or in four-unit modules in 19" frame. Use individual power supplies. One "450" case and power supply can serve any "350" Preamp.

PORTABLE INDICATORS FOR STRAIN, ETC.

Model 150-300/700 Wide Band Amplifier and Power Supply accepts "150" series preamplifiers — for use with low power galvanometers, oscilloscopes, panel meter. Freq. range DC to 10,000 cps (but limited by particular preamp range). Panel meter has center zero scale, 25 divisions each side of center.

ALL DATA SUBJECT TO CHANGE WITHOUT NOTICE

For complete data, call your local Sanborn Engineering Representative or write the Industrial Division in Waltham.

SANBORN COMPANY

Industrial Division

175 Wyman Street, Waltham 54, Mass.

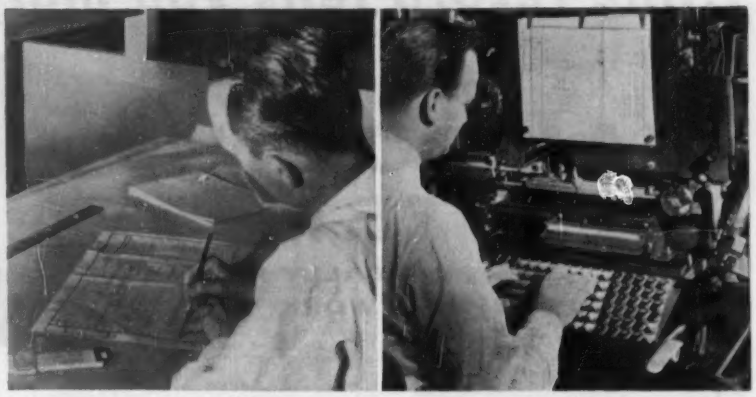
Machine Composes Schematics

MECHANICAL-PHOTOGRAPHIC process for preparing circuit diagrams provides an alternative to manual drafting. The master prints can be reproduced on letterhead-sized paper for filing and binding, or can be enlarged or reduced to any practical size.

The process was developed by Intertype Co., Brooklyn, N. Y., a division of Harris-Intertype Corp., and General Electric Co., Industry Control Dept., Roanoke, Va. It was initially developed for preparation of electrical diagrams. The process, however, is being expanded to cover other types of diagrams, including electronic as shown in Fig. 1.

Basic equipment is a Fotosetter photographic line composing machine. GE is now using it full time in the Roanoke plant and states that the diagrams produced are more legible, easier to handle and less costly than those produced by previous methods.

The engineer prepares a circuit sketch on a special form. The form has lines spaced horizontally and vertically in a ¼ inch grid pattern. The engineer uses the grid to locate symbols, nomenclature and other information. The lines are numbered for ready reference.



Engineer sketches circuit diagram on ruled form which is used by Fotosetter machine operator to compose schematic

The Fotosetter operator sets the diagram using the grid as a reference. He types out the diagram on the machine's keyboard, row by row. (Another electronic firm is considering an alternative reference method. The engineer makes his sketch on unlined paper. The machine operator places this under a clear plastic overlay containing the grid pattern and makes any minor position adjustments required, as he sets the type.)

The machine has circulating matrices containing film negatives of symbols and characters. Common symbols are contained in interchangeable magazines. Rarely-used symbols are hand inserted.

First film positive contains circuit symbols and wiring diagram

Diagram film in copy holder. Pointer guides setting of film

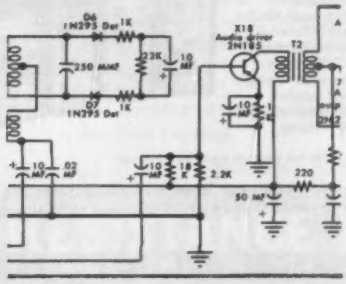


Fig. 1—Portion of sample electronic circuit diagram set by machine

Positives and master form are positioned on makeup grid. Wax holds them

How It Works

The operator first sets up the circuit with component symbols and wiring lines. A film positive is developed in a darkroom. This positive is placed in a position indicator in the machine and guides the operator in setting a second film containing nomenclature and other information.

The film positives are overlaid with a prepared film form containing title blocks. The backs of the positives are waxed so they will adhere under pressure and form a composite. The composite film is contact printed to make the final transparency. The transparency can then be used to produce prints photographically. Copies of the prints can be run off by diazo or other methods.

Copy is set 8.5 inches wide on

WESTINGHOUSE SILICON POWER RECTIFIERS

302 Up to 35 amperes half-wave. Weight: 0.65 ounce.

303 Up to 18 amperes half-wave. Weight: 0.65 ounce.

304 Up to 12 amperes half-wave. Weight: 0.25 ounce.

For efficient medium-power rectification on land, at sea and in the air

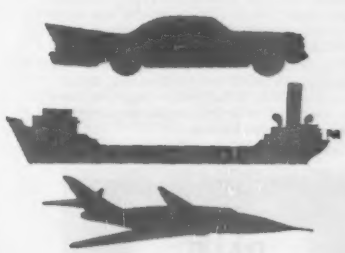
Westinghouse types 304, 303, and 302 rectifiers offer a range of current and voltage ratings which are ideal for efficient medium-power rectification.

All three types are immediately available from stock—and at an attractive price! They are characterized by long life, high efficiency, low regulation, low cost, and operation at high ambient temperatures (up to 190°C junction temperature). They meet or exceed requirements of all applicable military tests. And they are available in a variety of rectifier assemblies.

Listed below are some suggested applications.

- DC power supplies for ground and airborne
- 6-12-24-48 volt AC-DC generator systems
- Battery chargers
- Small plating supplies for laboratory use
- Power supplies for business machines
- Computer power supplies
- Transistor power supplies
- Telephone exchange DC power supplies
- Power supplies for marine smallcraft
- Electronic tube filament supplies

For further design data, contact your Westinghouse representative or write to Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Pennsylvania.



SILICON POWER RECTIFIERS • GERMANIUM TRANSISTORS • SILICON POWER TRANSISTORS

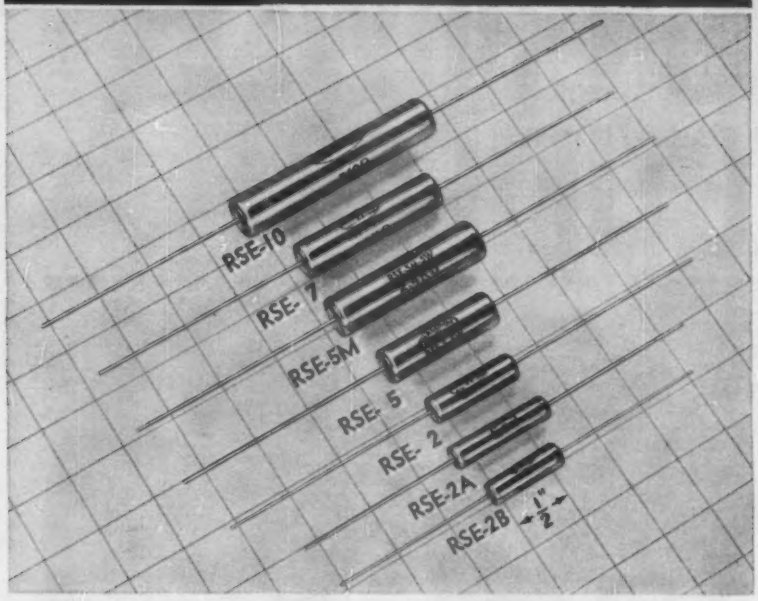
YOU CAN BE SURE...IF IT'S Westinghouse

COMING SOON—HIGH-SPEED GERMANIUM DYNISTOR SWITCH

featuring low stand-by currents, low internal power loss, and switching time in the milli-microsecond range. Watch for announcement of availability.

DALOHM Ω

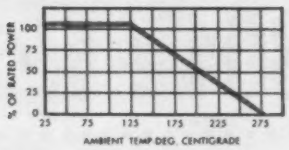
...for Complete Reliability Under Severe Environmental Conditions



TYPE RSE HERMETICALLY SEALED RESISTORS

Wire Wound, Precision, Miniature, Ruggedized

RSE-2A DERATING CURVE



JUST ASK US

The DALOHM line includes precision resistors (wire wound and deposited carbon); trimmer potentiometers; resistor networks; collet fitting knobs and hysteresis motors designed specifically for advanced electronic circuitry.

If none of the DALOHM standard line meets your needs, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

DALE PRODUCTS INC.
1300 28th AVE.
COLUMBUS, NEBRASKA

A precision wire wound power resistor encapsulated in shock absorbing material; then encased and sealed in a metal tube to overcome demanding environmental conditions, yet maintains miniature size.

This ruggedized resistor will surpass the most severe mechanical shock and vibration requirements.

- Rated at 2, 3, 5, 7 and 10 watts
- Resistance range from .5 ohms to 175K ohms, depending on size and type
- Tolerances: ±0.05%, ±0.1%, ±0.25%, ±0.5%, ±1% and ±3%.

TEMPERATURE COEFFICIENT: Within ± 0.00002/Deg. C.

COMPLETE PROTECTION: 100% impervious to moisture and salt spray.

WELDED CONSTRUCTION: Complete welded construction from terminal to terminal.

RUGGED HOUSING: Sealed and inserted in metal tubing.

SMALLEST IN SIZE: .220 x 11/16" to .395" x 1-61/64".

MILITARY SPECIFICATIONS: Surpasses MIL-R-26C

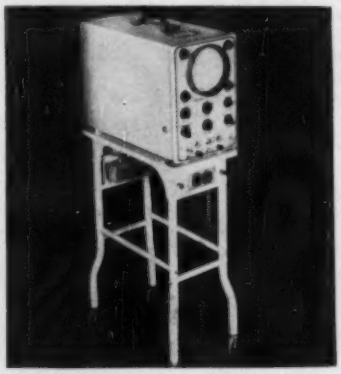
Write for Bulletin R-25

Process produces prints on letter-size paper. ¼ size of normal diagram

film or photographic paper. Film positives can be changed, to correct errors or to accommodate engineering changes, by cutting out unwanted portions of a positive and inserting new lines. According to GE, draftsmen quickly learn how to operate the machine.

Instrument Dollies for Close Quarters

By RONALD L. IVES
Palo Alto, Calif.

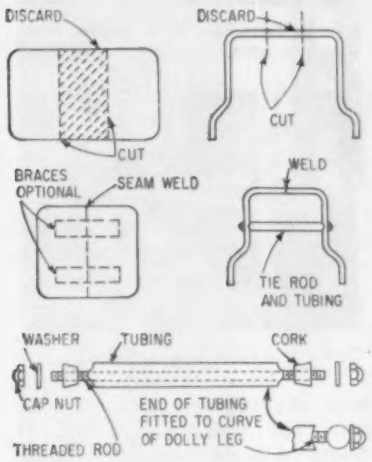


Outlet and ground posts are provided at front of dolly

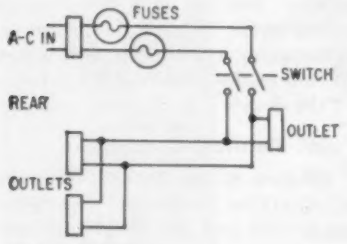
STANDARD INSTRUMENT dollies are usually too bulky for the back access alleys in rack bays of communication and radar stations or other tight locations. When time does not permit ordering custom-made dollies, slim carts may be made by "shrinking" small wheeled carts which stores sell as typewriter

stands or hostess carts.

The dolly shown was made from a typewriter stand with tube steel legs, stamped sheet iron top and skirting and casters on the feet. It is light in weight, but held a 600 pound static load without damage. The caster pins sheared at 700 pounds.



Method of trimming cart to size and bracing



Wiring diagram

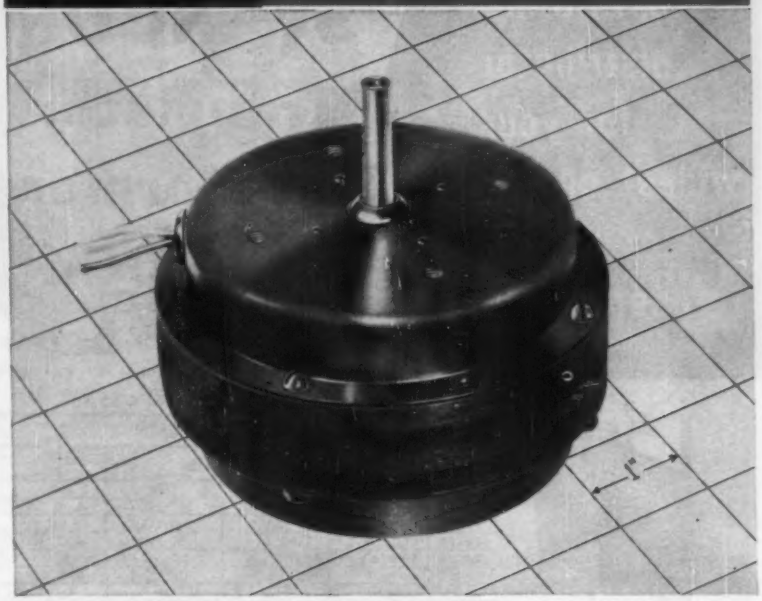
First step is cutting down the width of the chart if it is too wide. The flanged edges do not permit side-trimming, so a strip is sawed from the centers of the top, skirt and legs. The two halves are realigned and rejoined by welding. The weld is ground smooth and pits are filled with solder. This work can be done by an auto body shop.

The cart is made rigid by spot-welding or bolting cross braces under the top plate and tie rods into holes drilled in the legs. The rods, of ½ inch steel are bolted between the legs to keep them from spreading. Aluminum tubing, centered around the rods by corks and cut to fit the curvature of the legs, keep the legs apart.

A flanged steel tray can be hung

DALOHM Ω

announces NEW BREAK-THROUGH IN HYSTERESIS MOTOR DESIGN



HEAT RISE BARRIER IS LOWERED TO ONLY 20° - 38° C., DEPENDING ON H.P. RATING

Sub-Fractional Low Noise No Vibration Synchronous

The new DALOHM Hysteresis motor provides all the desirable characteristics of such motors, yet doesn't have the usual heat rise handicaps. Small and lightweight, its new pancake configuration is space saving.

- Low noise
- Maintains synchronous speed at rated load
- No vibration or magnetic strays
- Reaches full RPM in 1 revolution
- Exceptionally low cost
- Operates on any frequency up to 120 c.p.s., giving an infinite selection of speeds up to 3600 RPM

RUNNING TORQUE: 2.8 inch/oz. to 28 inch/oz.

VOLTAGE: 115 V., 60 c.p.s.

SPEED: 1800 RPM

Write for Bulletin R-80

Ideally suited for facsimile machines, Hi-Fi turntables, tape recorders, tele-metering and many other types of equipment where constant synchronous speed is essential.

JUST ASK US

The DALOHM line includes precision resistors (wire wound and deposited carbon); trimmer potentiometers; resistor networks; collet fitting knobs and hysteresis motors designed specifically for advanced electronic circuitry.

If none of the DALOHM standard line meets your needs, our engineering department is ready to help solve your problem in the realm of development, engineering, design and production.

Just outline your specific situation.

DALE PRODUCTS INC.
1300 28th AVE.
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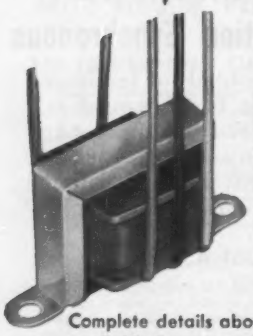
See your CHICAGO STANDARD distributor for your widest choice of STOCK transformers

30 NEW STANCOR Transistor Transformers IN STOCK

ACTUAL SIZE



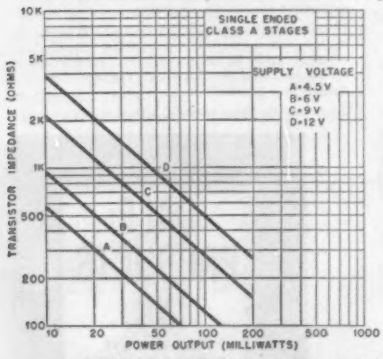
150 MW GROUP; 2 1/32" x 1 3/16" x 5/8"; wt. 0.65 oz.

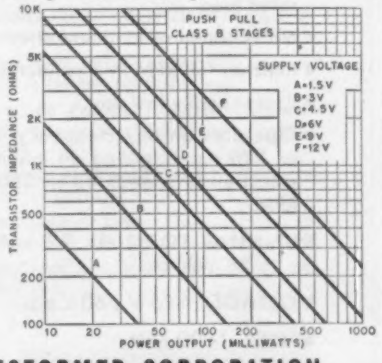
Stancor Part No.	Application	Turns Ratio Pri. to Sec.	Impedance in Ohms Pri.	Sec.
TA-18	Input	1.00:45.5	30 C.T.	50,000
TA-19	Interstage	3.08:1	100 C.T.	10 C.T.
TA-20	Output	5.22:1	350 C.T.	4, 12
TA-21	Output	5.53:1	500 C.T.	4, 8, 16
TA-22	Interstage	3.16:1	500 C.T.	50
TA-23	Output	5.65:1	600 C.T.	4, 8, 16
TA-24	Interstage	10.0:1	500 C.T.	50,000
TA-25	Output	6.75:1	825 C.T.	4, 8, 16
TA-26	Output	9.80:1	1,250	4, 12
TA-27	Interstage	4.08:1	1,200	20,000 C.T.
TA-28	Interstage	1.65:1	1,500	500 C.T.
TA-29	Output	11.8:1	2,500	4, 16
TA-30	Interstage	1.00:1.22	5,000 C.T.	7,500 C.T.
TA-31	Interstage	1.00:1.41	5,000 C.T.	10,000 C.T.
TA-32	Interstage	1.00:4	5,000 C.T.	80,000 C.T.
TA-33	Output	24.6:1	10,000 C.T.	4, 8, 16
TA-34	Interstage	14.0:1	10,000	200 C.T.
TA-35	Interstage	2.24:1	10,000	2,000 C.T.
TA-36	Interstage	1.83:1	10,000	3,000 C.T.
TA-37	Output	5.55:1	400 C.T.	11
TA-38	Interstage	3.44:1	500 C.T.	150 C.T.

300 MW GROUP; 1 3/16" x 1 5/8" x 3/4"; wt. 1.2 oz.

TA-39	Output	3.08:1	100 C.T.	4, 8, 16
TA-40	Output	3.27:1	160	4, 8, 16
TA-41	Output	5.00:1	400 C.T.	4, 8, 16
TA-42	Output	5.60:1	500 C.T.	4, 8, 16
TA-43	Output	6.63:1	700 C.T.	4, 8, 16
TA-44	Output	12.5:1	2,500	4, 8, 16
TA-45	Output	13.7:1	3,000	4, 8, 16
TA-46	Interstage	8.17:1	100,000	1,500 C.T.
TA-47	Input	1.00:14.1	1,000 C.T.	200,000 C.T.

Complete details about these new units are available in STANCOR Bulletin 546, available from your distributor or by writing direct to Chicago Standard.

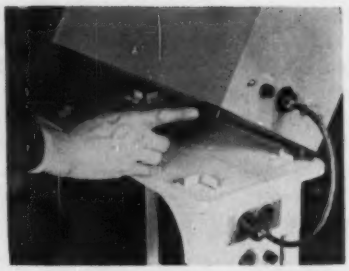




CHICAGO STANDARD TRANSFORMER CORPORATION

3502 ADDISON STREET • CHICAGO 18, ILLINOIS

Export Sales: Roburn Agencies, Inc., 431 Greenwich St., New York 13 N.Y.



Feet of instrument fit in angles. Rear electrical inlet and outlets can be seen

Tote tray is hung from leg braces

from the tubing to carry tools, cable and other equipment. It should be removable for cleaning. Means must be provided for keeping the instrument in place. The rubber feet of the oscilloscope shown were replaced with heavy, rectangular typewriter feet which fit into angles placed at the corners of the dolly's top.

Electrical Connections

Because of the chronic shortage of electrical connections, several a-c outlets and ground connections were provided on the dolly. At the rear, an a-c input, consisting of a sunken male plug, is installed in a utility box with 2 fuses, one in each side of the line. Above it is a dual outlet and at the bottom of the input panel are two grounded binding posts.

A combination switch and outlet is mounted on the front skirt. Because the dolly circuits are connected to the line through a cord, which may not preserve system polarity, both sides of the line are fused and switched. When the switch is "off", all outlets are electrically dead. Two grounded binding posts are mounted on the front skirt, on each side of the a-c plate. Electrical boxes and thin-wall conduit is used for strength and safety.

The dolly is finished with auto

Relay Sales

- Telephone Relays
- Midget Relays
- Keying Relays
- Rotary Relays
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- Stepping Relays
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Write for Catalog 1957-C9

Relay Sales

why wait for RELAYS

LEADING MAKES— LATEST TYPES IN STOCK!

Crystal Can Relay
Hermetically sealed, fast and sensitive. Withstands extreme temperatures, shock and vibrations. Plug-in, solder-hook and 3-in lead type available. Meets military specification MIL-R-25018, MIL-R-5707C except as to contact overloads

We maintain complete distributor stocks of the following makes:

Advance Relays	**Phillips Controls**
Automatic Electric	**Struthers-Dunn**
Clare	**Leach Relays**
Neomite-Elgin	**Terado and Others**

Potter & Brumfield

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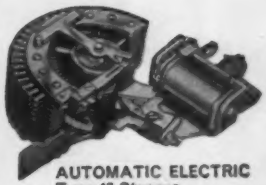
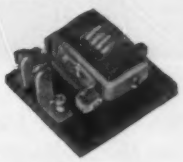
Relay Sales cannot get better delivery from manufacturers than you. Relays now in stock were ordered as long as 10 months ago and selected by men who have specialized in supplying relays to the industry for many years. The items illustrated are typical of hundreds of thousands in stock. They are available in all popular coil ratings and contact arrangements. Why wait for relays? Call us today!

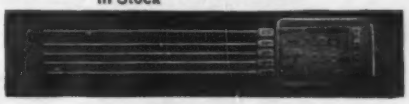


AUTOMATIC ELECTRIC
Type 45 Stepper
Wide Selection



STRUTHERS DUNN
Keying Relay
Many Types in Stock

PHILLIPS CONTROL
9QA Midget for Sub Chassis Mounting. Many Others in Stock



(Actual Size)
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Sub Miniature Hermetically Sealed Relay. All Advance Types in Stock.

Write or Phone for Same Day Shipment
Phone: West Chicago 1100
TWX West Chicago 3464

RELAY SALES, INC.
P.O. BOX 186-A TWX West Chicago, Ill, 3464-u

"Termaline" 50 ohm coaxial line Load Resistor
"Thruline" Directional RF Wattmeter
"Termaline" RF Absorption Wattmeter
...a need filled
Coaxial RF Switches
Coaxial RF Filters

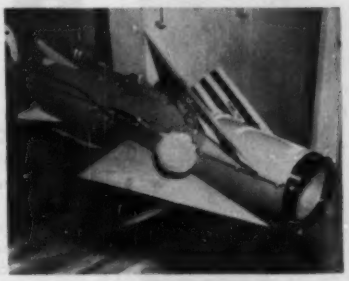
Since 1942 the Bird Electronic Corporation has met the challenge of a constantly growing electronic industry. Today, enlarged engineering facilities demonstrate our intention to maintain leadership in our field. A wide range of coaxial line instruments and accessories are being designed to meet a variety of specifications; and new applications are continuously being sought.

In addition to experience and established leadership, Bird has the physical facilities to produce and dependably deliver coaxial line instruments and accessories meeting your highly exacting requirements.

BIRD **ELECTRONIC CORP.**
EXpress 1-3535
1800 E. 38 St., Cleveland 14, Ohio
Western Representative:
VAN GROSS COMPANY • Woodland Hills, California

spray paint, after degreasing. Infrared dried crackle finish and linoleum, formica or masonite can be cemented on the top. All have given excellent field service although masonite is susceptible to mould in the tropics.

Bubble Gum Bubbles Find Leaky Joints

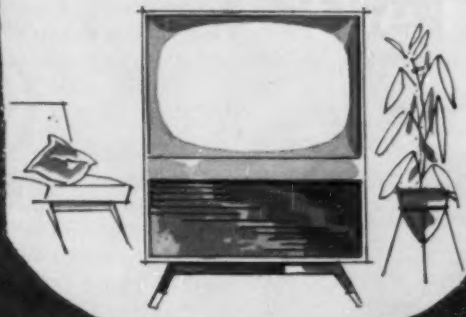


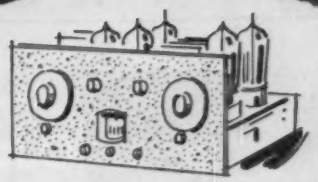
CHEWED PENNY bubble gum is a good leak detector. Douglas Aircraft Co., Santa Monica, Calif, uses it to find leaks in joints in the pneumatic lines in Nike missiles. The high pressures required make it necessary to test the lines in chambers from which employees are barred. Soap bubbles, sniff tests and other methods can't be used because the evidence of leaks doesn't remain after the line pressure falls. The gum bubbles, or burst bubble residue, keep the leak pinpointed.

Magnetic Pencil Lifts Small Magnetic Parts

MAGNETIC PICKUP tool has tip which can be instantaneously magnetized or demagnetized by a spring-loaded plunger. Depressing the plunger with the finger brings a permanent magnet in contact with the tip, magnetizing it. It can assemble or sort miniature and delicate ferromagnetic parts according to Orbit Industries, Resada, Calif.

FROM "GIANT" 10-INCHERS TO "SUPER-COLOSSAL" 27'S . . . early black-and-white to the latest rainbow colors . . .

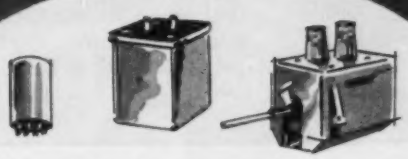




FROM PRIMITIVE "TRF'S" TO THE HIGHEST OF THE "FI" . . . the earphone era to the most modern of radios.

KESTER SOLDER

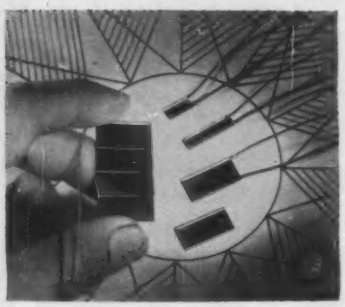
COMPANY • 4204 WRIGHTWOOD AVENUE • CHICAGO 39, ILLINOIS
NEWARK 5, NEW JERSEY • BRANTFORD, CANADA



FOR MORE THAN HALF A CENTURY, one of the "constants" of the ever-expanding electronics industry has been Kester Solder. Equipment and components originally soldered with Kester continue to give excellent service; regardless of their age, the soldered joints stay in perfect condition for the life of the unit. That's why Kester Flux-Core Solder has the greatest acceptance in the industry . . . why you should always insist on Kester.

WRITE TODAY for the KESTER 78 page textbook "Solder . . . Its Fundamentals and Usage." Free!

NEW PRODUCTS

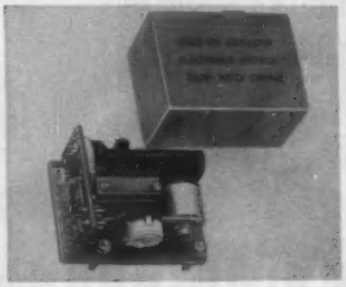


Silicon Solar Cells ruggedized

International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif., announces Silicon Solar cells capable of converting 10 percent and higher of the radiant energy falling on their surface. They are available for both commercial and military applications, and are capable of providing an output of approximately 9 w per sq ft of active cell area in bright sunlight. The high efficiency and rugged construction is due in part to new alloying techniques which permanently bond the contact to the silicon wafer, making the contact an integral part of the cell itself, while still allowing soldering of individual cells. **Circle 300 on Reader Service Card.**

Variable Oscillator high repeatability

Bulova Watch Co., 40-06 62nd St., Woodside 77, N. Y., announces variable frequency crystal controlled oscillators in small size. The VCF series features automatic frequency control or variation of nominal frequency by the application of an external voltage. Frequency range is from 10 kc to 20 mc, with obtainable variations up to 6 cps at 10 kc, and up to 12 kc at 20 mc. The resolution on these shifts is infinite depending on the stability and resolution of the modulating voltage. Drift, after stabilizaton, can be kept to less than 1 part in 1 million. **Circle 301 on Reader Service Card.**



Tachometer transistorized

The Airpax Products Co., City of Plantation, Ft. Lauderdale, Fla. The completely transistorized Tach-Pak, requiring no warmup time, is designed to convert a signal frequency from a magnetic transducer to a d-c current proportional to frequency and rpm. The proximity pickup is not attached to any moving system component. For control, monitoring and measuring applications, all units in this series 5400 have a linearity of 0.25 percent in ranges from 0 to 60,000 rpm. **Circle 302 on Reader Service Card.**

Coaxial Tuners double slug type

Microlab, 71 Okner Parkway, Livingston, N. J. A new group of coaxial double slug tuners have been designed covering the frequency range from 300-5,000 mc. The separation of the two slugs mounted in a 50-ohm transmission line may be adjusted and locked as desired. The tuners are available for standing wave ratios less than 2:1 and less than 10:1. **Circle 303 on Reader Service Card.**

I-F Transformers subminiaturized

Wells Electronics Co., 1707 S. Main St., South Bend 23, Ind., announces the Weecoil 500 line of subminiature i-f transformers for transistorized circuits. It consists of a single-tuned i-f, a double-tuned i-f, a diode filter i-f, a 7-pin i-f for use with drift transistors, and an oscillator coil—all on bases that are approximately ½ in. square. Q's up to 165 can be obtained with regular components, and up to 200 if the transformers are unshielded. Although primarily de-

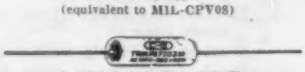
MILITARY "CPM" SERIES
in accordance with Spec.
MIL-C-14157A
300, 400, 600 volts DC Working

Uninsulated Body Type CPM08

Insulated Body Type CPM09

MILITARY & INDUSTRIAL
"TWK" SERIES
in accordance with
MIL-C-26244 (USAF)
200, 300, 400, 600 volts DC Working

Uninsulated Body Type TWKN
(equivalent to MIL-CPV08)



Insulated Body Type TWKP
(equivalent to MIL-CPV09)

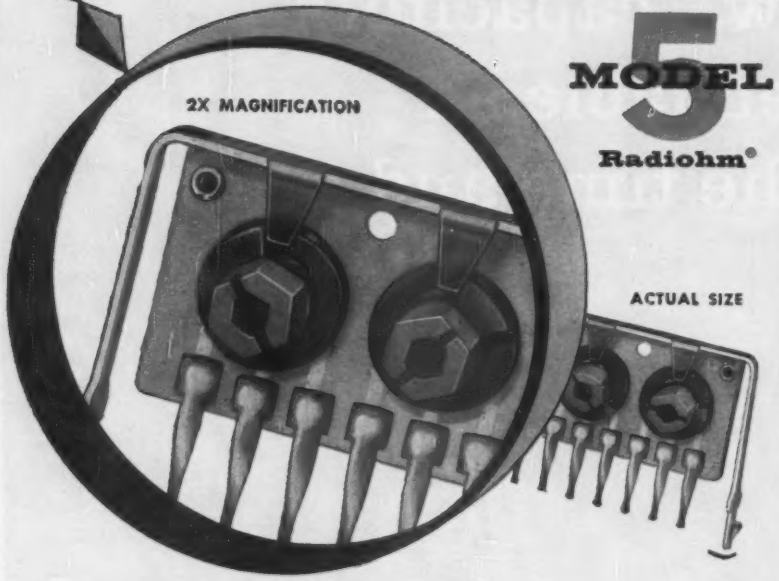
CAPACITANCE:
001 mfd. to 1.0 mfd.
TEMPERATURE RANGE:
—55°C to +125°C.

Cornell-Dubilier Certified High-Reliability Capacitors meet performance expectations for new environments and new complex military and industrial electronic equipment. These capacitors meet or surpass the exacting requirements of MIL-C-14157A and MIL-C-26244 (USAF). Each production lot is furnished with certified test data covering the stringent test program detailed in the specification.

When designing electronic equipment where *failure can't be tolerated* specify Cornell-Dubilier High-Reliability Capacitors. Write on your company letterhead for High-Reliability Bulletins 188A-1 and 188A-2 to Dept. 000, Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

Consistently Dependable
CORNELL-DUBILIER
CAPACITORS

5 Exclusive Features in the Centralab.



The only ¼ watt multiple miniature variable resistor*

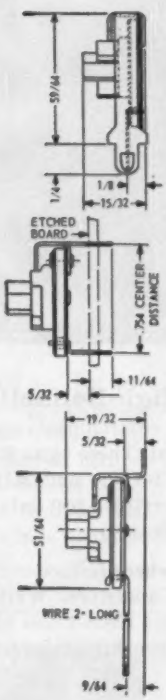
that gives you these 5 exclusive and important advantages

1. **LOWER COST:** These compact units with superior electrical characteristics actually cost less than larger units of equivalent rating now on the market.
2. **REDUCED SIZE:** 1 to 4 variable resistors on a single steatite base plate. The 4-resistor unit measures only 2¼" x ¾". Units with fewer resistors are propotionately smaller.
3. **VERSATILITY:** Available with horizontal or vertical mounting brackets, plug-in terminals for printed circuit boards or wire leads for metal chassis.
4. **SUPERIOR KNOB CONSTRUCTION:** Unusual knob design permits adjustment with an internal or external hexagon wrench, screwdriver or by fingertip.
5. **FLEXIBILITY:** Fixed resistors and capacitors can be incorporated in the Model 5 to make a complete operating circuit.

SPECIFICATIONS:

Resistance Range: 1000 ohms to 5 megohms, ±35%, linear taper
Wattage Rating: ¼ watt at 70° C. ambient
Breakdown Voltage: 1250 Volts RMS, between adjacent sections and to bracket
Minimum End Resistance: Less than 1%
Rotational Life: 5% change after 250 rotations
Initial Torque: 2 inch ounces average; 50% change after 250 rotations

Write for Centralab Bulletin EP-539 giving full specifications on the Model 5 Radiohm® series.



Centralab ®

*Patent allowed Y-5834

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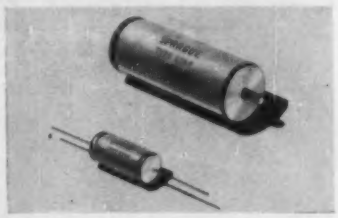
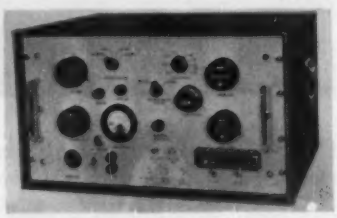
VARIABLE RESISTORS • PACKAGED ELECTRONIC CIRCUITS • ELECTRONIC SWITCHES
CERAMIC CAPACITORS • ENGINEERED CERAMICS • SEMI-CONDUCTOR PRODUCTS

signed for the radio industry, Weecoil transformers are available for a range of industrial and military applications from 100 kc to above 10.7 mc. **Circle 304 on Reader Service Card.**



Tubular Capacitors glass-encased

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass. A new series of glass-encased tubular capacitors for h-v applications employ a dual-dielectric and polyester plastic-film and paper. Type 205P features a new design of glass-to-metal end seal which, coupled with new protective sealing techniques, results in the practical elimination of impregnant leaks which have so often been the case with earlier designs of glass tubular capacitors. A complete description is given in engineering bulletin 2312, available on letterhead request.



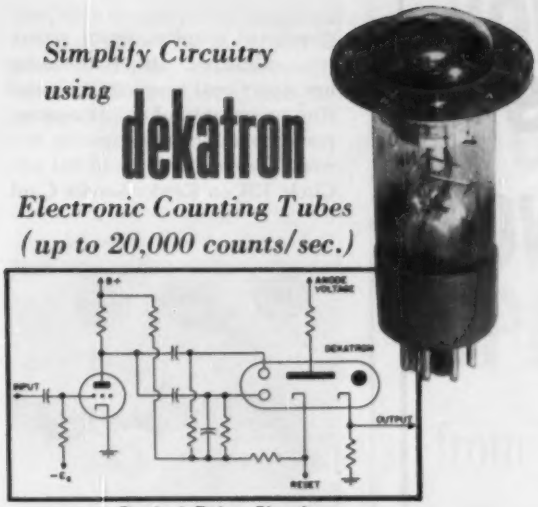
Transponder Tester weighs only 59 lb

KEARFOTT CO., 14844 Oxnard St., Van Nuys, Calif., announces a new ATC L-band transponder test set. It performs all the testing features required to check out L-band airborne transponders manufactured to ARINC characteristics 532B and ANDB (AMB) 2.3 NAIB. Important among its features are a double pulse generator (with provision for third pulse); strip-transmission line

Simplify Circuitry using

dekatron

Electronic Counting Tubes (up to 20,000 counts/sec.)



Typical Drive Circuit

As a user of DEKATRON cold cathode glow-transfer counting tubes, you are welcome to use this and many other drive circuits designed by us. Circuits are patented (or applied for) but are available to DEKATRON customers on a royalty-free basis.

Write to us for complete information.

Baird-Atomic, Inc.
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Instrumentation for Better Analysis

CIRCLE 95 READERS SERVICE CARD

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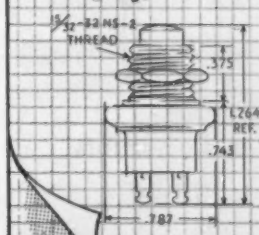
DOUBLE POLE
Series 35-1
PUSH BUTTON SWITCH

- Double-pole, single-throw, silent-action, momentary contact. Normally open.
- Conservatively rated 1/2 ampere at 115 volts, AC, resistive.
- Life expectancy approximately 100,000 operations.
- Housing and button of molded phenolic. (MIL-M-14, Type CFG).



Answers a demand for a miniature double pole switch.

Write for complete details

Telephone Fleetwood 4-1040

Grayhill INC.

523 Hillgrove Avenue, La Grange, Illinois

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In this brochure—complete facts on DIALCO's

DATALITES®

For the Computer-Automation Industries

DATALITES by DIALCO are ultra-miniature Indicator Lights specially designed to meet the critical requirements of the computer-automation fields. Made in 2 basic styles: *Lamp Holders with* DIALCO'S own *replaceable Lamp Cartridges* (see above); or integrated DATALITES *with Built-in Neon Lamps* which are *not replaceable* (see below). Ultra-compact, single units mount in 3/8" clearance hole; the twin-lamp assembly mounts in 3/4" clearance hole.

LAMPS USED:
T-1¾ wire-lead incandescent lamps, or NE-2E neon lamps, in aluminum sleeves capped with plastic lenses (7 colors).
No. 249-7840-1431
(Illust. approx. actual size)
DATALITES with Built-in NE-2E Neon Lamps
No. 249-7841-931 with built-in resistor
No. 250-7840-1431
With Rotatable Lenses
No. 250-7841-1431 with built-in resistor

DATALITES have fully insulated terminals and conform to all applicable military specifications. Integrated units are available *with* or *without built-in resistors.* The cylindrical lenses can be hot-stamped with digits, letters, etc. Complete details in *Brochure L-160.* Send for it now.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

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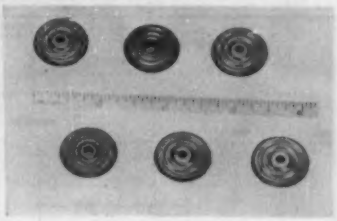
directional couplers; signal generator; calibrated strip-transmission line directional couplers; calibrated strip-transmission line attenuators; power monitor; pulse spacing network; adaptability to ramp test sets. **Circle 305 on Reader Service Card.**



Pressure Elements

capsular devices

THE BRISTOL CO., Waterbury, Conn., has developed a wide selection of capsular pressure elements $\frac{3}{8}$ in. o-d. This has proved a desirable size for applications in which miniaturization is an important factor. The elements are available for either internally or externally applied pressures, in ranges from 15-350 psi. Excellent linearity and very low hysteresis are characteristic. **Circle 306 on Reader Service Card.**

Standard Capacitors

values to 0.1 μf

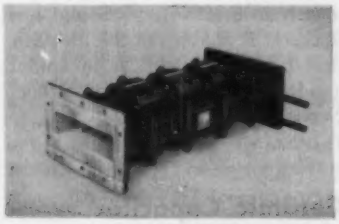
ARCO ELECTRONICS INC., 64 White St., New York 13, N. Y. ARCO standard capacitors are stabilized silvered mica dielectric units in values up to 0.1 μf. The capacitance values above 0.1 μf are fabricated using a combination of silvered mica and polystyrene dielectrics. The latter design improves the

insulation resistance and dissipation factor exhibited by mica, and in addition enables maintenance of miniaturized enclosure. **Circle 307 on Reader Service Card.**

Ribbon Cable

in widths up to 3 in.

HITEMP WIRES, INC., 1200 Shames Drive, Westbury, N. Y., announces a new, improved ribbon cable called Tempbraid. Manufactured in widths of from ¼ to 3 in., parallel Teflon lead wires are woven with Teflon and other yarns into a flat, extremely flexible ribbon. By impregnating the yarns, slitting the ribbon is feasible, permitting the construction of small inexpensive harnesses. Increased numbers of conductors can be placed in square or rectangular channels, due to the greatly improved space factor of square and rectangular harness construction. **Circle 308 on Reader Service Card.**



Ferrite Isolator

high-power, L-band

RAYTHEON MFG. CO., Waltham 54, Mass. Model 1LH2 high-power L-band microwave ferrite isolator is constructed of half-height wave-

NOW...a HIGH SENSITIVITY LOW COST SPECTRUM ANALYZER from 10 mc to 44,000 mc with ONE TUNING HEAD

PANORAMIC'S advanced new MODEL **SPA-4**

A new and welcome addition to Panoramic's long line of widely accepted and completely dependable Spectrum Analyzers, the SPA-4 covers frequencies from 10 mc to 44,000 mc in one low-cost compact unit that provides better sensitivity than found in typical multi-tuning head spectrum analyzers.

Backed by Panoramic's forward thinking, long and specialized experience in the development of spectrum analyzers, the SPA-4 embodies the human engineering and stable, direct reading displays that facilitate rapid and reliable analyses of measurement problems.

The SPA-4's many unique features, tremendous flexibility and single operation make it unsurpassed for analysis of FM, AM and pulsed systems, instabilities of oscillators, noise spectra, detection of parasitics, studies of harmonic outputs, radar systems and other signal sources.

- Better sensitivity than with typical multi-tuning head spectrum analyzers
- Resolution continuously variable from 1 kc to 80 kc for analysis of wide and narrow pulsed RF signals
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- Careful shielding to avoid interference
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guide to reduce size and weight. It is 6 in. high, 8 11/16 in. wide, 17 in. long, and weighs 34 lb. Built-in transitions to full-height guide provide match over the entire band so as to combine high performance with high power capacity. Minimum transmit/receive isolation is 11 db; maximum insertion loss is 0.55 db. Average power handling capacity is 2¼ kw, peak power is 3 megawatts. **Circle 309 on Reader Service Card.**

Test Set for igniter circuits

ALLEGANY INSTRUMENT CO., INC., 1091 Wills Mountain, Cumberland, Md. Model 101-5AF is a rugged igniter circuit tester. With only 0.005 ampere output, it measures igniter circuit resistance to an accuracy of ± 0.05 ohm or better, allowing the user to isolate a fault, which a less accurate instrument cannot do. It is used primarily in field testing of solid fuel rockets. It is also valuable in static test facilities as well as in igniter production. **Circle 310 on Reader Service Card.**

Ceramic Capacitor subminiature

TELECOMPUTING CORP., 915 North Citrus Ave., Los Angeles 38, Calif., announces a new subminiature ceramic capacitor with high reliability over a broad temperature range. It is designed for highest capacity per unit area, for applica-

Here's information you'll want on STANDARD precision timers

Accurate, reliable, versatile Elapsed Time Indicators. Synchronous motor drive, manual or electric zero reset. Electric clutch controlled by manual or automatic switch or output of electronic tubes. Units available for flush panel mounting or portable use.

Model	Scale Divisions	Totalizes	Accuracy
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S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

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THE STANDARD ELECTRIC TIME COMPANY
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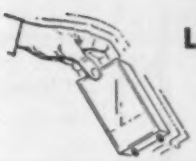
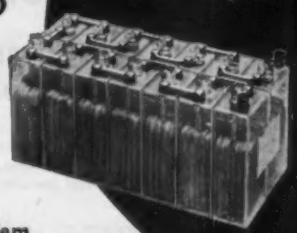
CIRCLE 201 READERS SERVICE CARD

make the acid test!





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the answer to any portable power problem

- new method used for completely sealing all binding and terminal posts, prevents any leaking or creeping of electrolyte
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COLOR and Monochrome dc to 5 mc lab & tv 5" OSCILLOSCOPE
#460
Factory-wired $129.50
Kit $79.95

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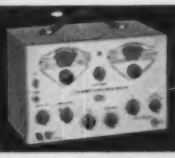
Flat from DC-4.5 mc, usable to 10 mc. **VERT. AMPL.:** sens. 25 rms mv/in; input Z 3 megs; direct-coupled & push-pull **thruout;** K-follower coupling bet. stages; 4-step freq-compensated attenuator up to 1000:1. **SWEEP:** perfectly linear 10 cps-100 kc (ext. cap. for range to 1 cps); **pre-set TV V & H positions** (30 & 7875 cps); auto. sync. ampl. & lim. **PLUS:** direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite graph screen; dimmer; filter; bezel fits std photo equipt. High intensity trace CRT. 0.06 usec rise time. Push-pull hor. ampl., flat to 400 kc, sens. 0.6 rms mv/in. Built-in volt. calib. Z-axis mod. Sawtooth & 60 cps outputs. Astig. control. Retrace blanking. Phasing control.



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DYNAMIC CONDUCTANCE Tube & Transistor Tester
#666
Factory-wired $109.95
Kit $69.95

COMPLETE with steel cover and handle. SPEED, ease, unexcelled accuracy & thoroughness. **Tests all receiving tubes** (& Color & Monochrome pic tubes with adapter). **Composite indication** of Gm., Gp & peak emission. **Simultaneous sel** of any 1 of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot). **New series-string voltages:** for 600, 450, 300 ma types. **Sensitive** 200 ua meter. **5 ranges meter sensitivity** (1% shunts & 5% pot). **10 SIX-position lever switches:** free-point connection of each tube pin. **10 pushbuttons: rapid** insert of any tube element in leakage test circuit & speedy sel. of individual sections of multi-section tubes in merit tests. **Direct-reading** of inter-element leakage **in ohms.** New gear-driven rollchart. **Checks n-p-n & p-n-p transistors:** separate meter readings of **collector leakage current & Beta** using internal dc power supply.

EICO
See the 50 EICO models IN STOCK at your neighborhood distributor. Write for FREE Catalog E-12
33-00 Northern Boulevard, L. I. C. 1, N. Y.

CIRCLE 203 READERS SERVICE CARD

*EXPERIENCE SINCE 1894

Built into American Beauty ELECTRIC SOLDERING IRONS

*EXPERIENCE: "Knowledge, Skill, Or Technique Resulting From Experience."

Since 1894 we have been designing, manufacturing and constantly improving our electric soldering irons! Today, no matter what the requirements, there's an American Beauty in the right model, correct tip size and proper watt input to do any soldering job quickly, properly, efficiently.

TEMPERATURE REGULATING STAND

An automatic device for controlling tip temperature while iron is at rest. Prevents overheating of iron and eliminates frequent retinning of tip, while at same time maintaining it at any temperature that may be desirable or necessary.

Write for 16-page illustrated catalog containing full information on our complete line of electric soldering irons—including their use and care.

AMERICAN ELECTRICAL HEATER COMPANY

172-G DETROIT 2, MICHIGAN

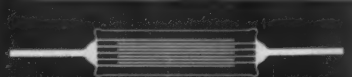
CIRCLE 260 READERS SERVICE CARD

Vitramon® CAPACITORS

will help you build MINIATURE ... circuit systems

VITRAMON capacitors are as small as this

Life Size Photograph



Two materials — a monolithic block of porcelain enamel and fine-silver electrodes — fused into one strong, stable, efficient and effectively homogenous RELIABLE unit.

Sheer bigness . . . great in Texas . . . has no place in an electronic circuit. VITRAMON capacitors save you space and deliver critical electrical performance at the same time.

MINIATURE? YES! PLUS . . .

RUGGED LOW LOSS STABLE
WIDE TEMPERATURE RANGE
LOW NOISE VAPORPROOF

The biggest names in electronics use VITRAMON capacitors in guided missiles, jet ignition, proximity fuses and in radar, servo, guidance, fire control, telemetering and carrier telephone systems.

If substitutes are not good enough... if you need the best . . . write today!

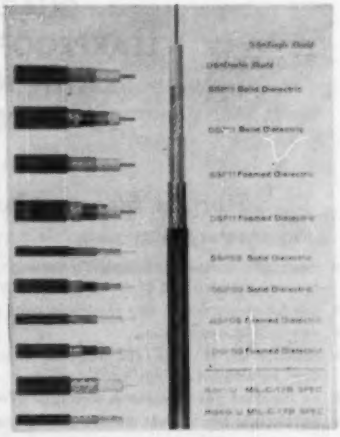
Vitramon® Incorporated

BOX 544 A. • BRIDGEPORT 1 • CONN.

tions where space is critical. The tiny, rugged units are rated at 200 wvdc. Capicity variation is only ±10 percent of room temperature capacitance in a range from −55 to +150 C. This stability results from a new production-controlled ceramic dielectric with high density and high K. **Circle 311 on Reader Service Card.**

Power Resistors molded covering

OHMITE MFG. CO., 3697 Howard St., Skokie, Ill. New, molded, wirewound resistors are provided in precision tolerances at relatively high wattages—3, 5, and 10 w. Temperature coefficient of resistance is low −0 ±20 ppm per deg C. Resistance wire is wound in a single layer on ceramic cores. The covering of the resistor is a jacket of tough, resilient, Silicone-ceramic material molded around the resistor under great pressure. This technique provides a denser, smoother, moisture-proof covering, gives improved heat dissipation and reduced hot spot temperatures. **Circle 312 on Reader Service Card.**



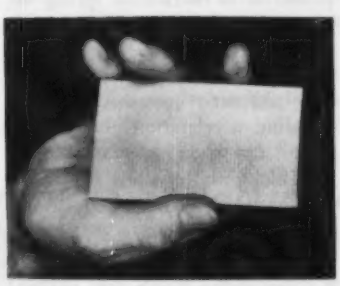
Coax Cables ten types

ENTRON, INC., 4902 Lawrence St., Bladensburg, Md. Eight completely new types and two conventional types of r-f transmission and distribution coaxial cables for community tv antenna and similar

systems have been placed on the market. All have a characteristic impedance of 75 ohms. Both single-shield and double-shield models are available in the new group. All feature low loss, long life and low cost. **Circle 313 on Reader Service Card.**

Crystal Test Set portable unit

AIRBORNE INSTRUMENTS LABORATORY, 160 Old Country Road, Mineola, N. Y. The type 390A-3, via a simple d-c technique, measures the important characteristics of microwave crystals in mixer and detector applications. The test set measures relative noise figure, relative sensitivity, match of crystal pairs, conversion loss, and noise temperature. **Circle 314 on Reader Service Card.**



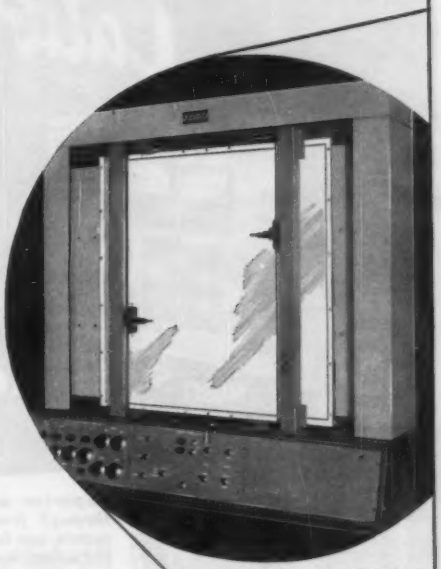
Silicone Laminate high heat resistance

CONTINENTAL-DIAMOND FIBRE CORP., Newark 100, Del. Dilecto GB-89S is made from a coarse weave continuous filament glass fabric bonded with a silicone laminating resin. This new grade com-

ELECTRONIC ASSOCIATES Incorporated — LONG BRANCH, NEW JERSEY · CAPITOL 9-1100

- Smaller Size
- Less Weight
- Faster Response
- Greater Reliability
- Instant Warm-up

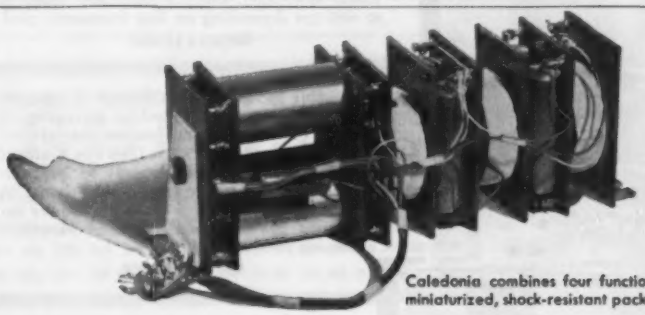
EAI's new Transistorized Variplotter, Model 205-T, assures these X-Y plotting advantages and includes many more — vertical or horizontal operation, disposable ink cartridges, vacuum hold-down, established reputation, etc. Bulletin No. PIR 841 further details these advantages.



EAI's new Transistorized Variplotter,

Have you explored the advantages of analog simulation in solving your design problems? Write for Application Bulletins describing successful applications in your industry.

CIRCLE 251 READERS SERVICE CARD



Caledonia combines four functions in miniaturized, shock-resistant package.

Electronics today is partly packaging

PROBLEM: Design a small (50 cubic in.) and light (3¾ lbs.) unit that contains:
1. a positive d.c. pulse selector
2. a negative d.c. pulse selector
3. a high level 60 cps band pass filter
4. a 400 cps detector circuit

(all with tight tolerances, naturally).

Design it to operate within the usual military environmental conditions, including high vibration and shock.

SOLUTION: We assembled the components shishkabob style. Then mounted the

kabob in a metal case filled with an epoxy foam compound to hold the parts in a firm cushion.

TIME ELAPSED: From original assignment, through design to volume production—two months.

If such quick, dependable assistance in design and production can make your work more effective, we'll be glad to hear from you. We offer experience, good production facilities, and a recognized quality record.

CALEDONIA

ELECTRONICS AND TRANSFORMER CORPORATION

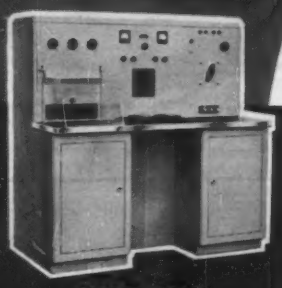
Dept. E-12 Caledonia, N. Y. • *In Canada:* Hackbusch, Ltd., 23 Primrose Ave., Toronto 4, Ont.

CIRCLE 205 READERS SERVICE CARD

from
Instrument Calibration
HEADQUARTERS

a modern method of maintaining ACCURACY

Superior and sustained quality control, through frequent calibration of test instruments, can be achieved by semi-skilled personnel using these self-contained standards.

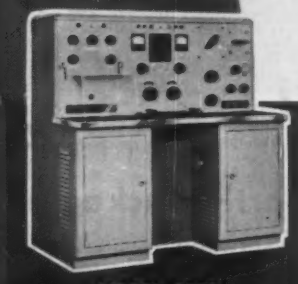


Portable Model 829 calibrates both AC and DC meters over ranges from 0.25 millivolt to 2000 volts and 2 microamperes to 20 amperes. Direct reading accuracy of 1% (0.5% using charts supplied). Output frequency from 50 to 400 cps depending on line frequency used.

Net price $2,650.

Console Model 261B calibrates all types of AC meters to direct reading accuracies of 0.5% (0.25% using calibration charts) over frequency range of 50 to 1600 cps. Current range from 1.5 milliamperes to 200 amperes; voltage range from 75 millivolts to 1500 volts. Output of electronic power oscillator has less than 5% total harmonic content at 60 cycles.

Net price $9,250.



Model 262B Dual Potentiometer Standard calibrates DC electrical measuring instruments to direct reading accuracies of 0.1% (0.05% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes. Employs Weston instruments and standard cells.

Net price $15,600.

Prices are f.o.b. Boonton, N.J. & subject to change without notice.

WE CAN HELP YOU

Technical and application data for our six basic models are fully described in a new 24-page catalog. Send for it today.

RFL Radio Frequency LABORATORIES, INC. Boonton, New Jersey, U.S.A.

bines high resistance to heat, flame, arc and moisture with good electrical and mechanical properties. Typical properties are available on request. **Circle 315 on Reader Service Card.**

VOR/ILS

in one indicator

LEARCAL DIVISION, Lear Inc., 3171 S. Bundy Drive, Santa Monica, Calif. Model 4087 flight indicator displays course selection, reciprocal course heading, "to-from" indication, lateral course deviation, glide slope indication, glide slope flag alarm, localizer indicator, localizer flag alarm and heading changes. **Circle 316 on Reader Service Card.**

Linear Accelerometer

low threshold

MINNEAPOLIS-HONEYWELL, 40 Life St., Boston 35, Mass. Type LA-600 a-c linear accelerometer consists of a non-pendulous seismic mass supported on a frictionless spring suspension and incorporates an a-c variable reluctance type pick-off. Designed for aircraft and missiles, it is inherently insensitive to cross-coupling accelerations both when at null and when under an acceleration along its sensitive axis. The new unit also features magnetic damping for near-constant damping ratio, from −65 F to + 250 F. It is hermetically sealed and requires no warmup time. **Circle 317 on Reader Service Card.**

Oscilloscopes

17 and 21 in.

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., 250 Garibaldi

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✳FOR SPECIFIC ITEMS IN MULTI-PRODUCT ADVERTISEMENT

Certain multi-product advertisements contain Reader Service numbers for each product.

For multi-product advertisements that are not keyed for Reader Service, indicate in box on postcard marked with asterisk (*) ad circle number(s) and specific product(s) on which you want more information.

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INSIDE FRONT COVER — INSIDE BACK COVER

MEMO:

NEW PRODUCTS RELEASES

TO: ALL MANUFACTURERS

FROM: electronics

electronics publishes all new product items of interest to makers and users of electronic and allied equipment.

The reverse side of this card provides a service to subscribers by facilitating the flow of additional information between manufacturers and our readers.

Take advantage of Reader Service--and the readership of electronics...keep the industry informed about your New Products and New Literature via their mention in the editorial pages of electronics.

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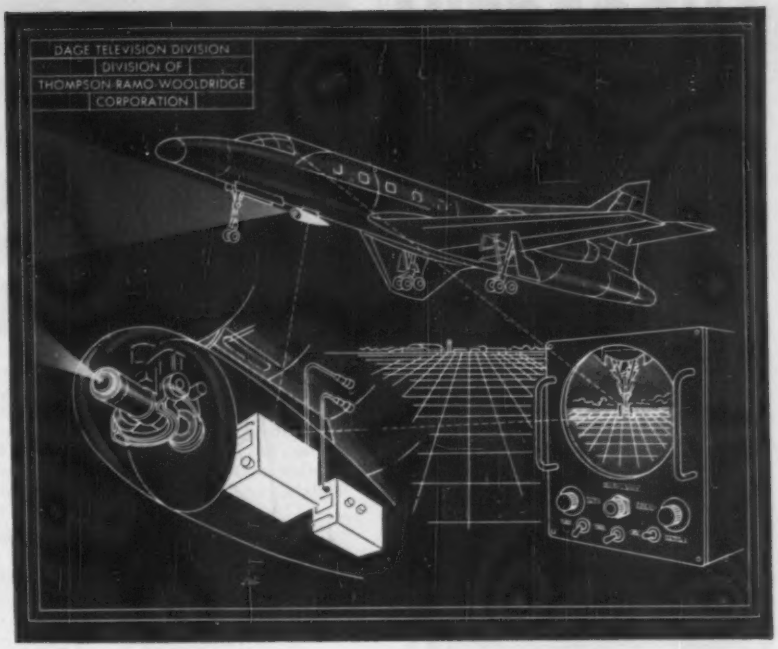
Ave., Lodi, N. J., has developed 17 in. and 21 in. oscilloscopes which accurately measure voltages and currents in the frequency range from d-c to 250 kc. The scopes provide a linearity of better than 1 percent over a calibrated scale 10 in. by 15 in. Voltage measurement accuracy is better than 2 percent without calibration. Accurate performance is assured by means of a high precision magnetic deflection system. **Circle 318 on Reader Service Card.**

Digital Voltmeter transistorized

BECKMAN SYSTEMS DIVISION, 325 N. Muller Ave., Anaheim, Calif. Accuracy and resolution of the new model 81 digital voltmeter is 0.015 percent over the three automatically switched ranges of ±10, ±100, and ±1,000 v d-c. Input impedance of the instrument is 10 megohms at all times, even when digitizing and under conditions of overload. Unit is ideally suited for use in applications such as production testing, precision research measurements, telemetry, and alarm monitoring. **Circle 319 on Reader Service Card.**

Transistor Amplifier quadrature rejection

M. TEN BOSCH, INC., 80 Wheeler Ave., Pleasantville, N. Y. Model 18050500 is a high temperature, miniaturized, hermetically-sealed, plug-in transistor amplifier featuring quadrature rejection, high impedance input, and low impedance output. It is primarily intended to



DAGE *relies on new Proto-Circuits Division*

for printed wiring prototypes

Dage Television needed printed wiring prototypes—in a hurry. The project: the 1st Airborne Transistorized MIL Qualified TV System, for automatic, fully stabilized control of Photo Reconnaissance Cameras.

Dage's choice: PROTO-CIRCUITS Division of PHOTOCIRCUITS.

Only PHOTOCIRCUITS offers you such a complete, separate prototype facility. PROTO-CIRCUITS' streamlined organization—from design through tooling—cuts paperwork and overhead to the bare minimum. You get *fast service* at *low cost*, whether you're next door or across the country.

You get *better* prototypes, because PROTO-CIRCUITS uses the same highly refined production techniques utilized by PHOTOCIRCUITS.

The transition from prototype to production is a smooth one, free from awkward, costly mistakes and misunderstandings. PHOTOCIRCUITS' unique and unequalled production capacity assures a steady, on-time flow of boards, regardless of quantity.

Dage made the logical choice—based on high quality, low cost, fast service. For the same reasons, you too should contact PROTO-CIRCUITS for your prototype needs. Write or call Department 1135 for full information today.

PC Photocircuits CORPORATION

GLEN COVE, NEW YORK

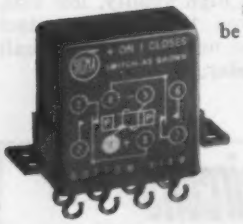
PHONES GLEN COVE 4-8000 FLUSHING 7-8100 | CABLE PHOCIRCO

for the engineer
who has <u>everything</u>

With the same Philanthropic Genius responsible for such world-renowned items as Finder-Fixing Kits, micromccarthys, automation relays and other assorted contributions to the scientific community, Sigma now proudly offers a new GIFTRELAY just in time for Christmas.

Model 1932 WPA G.R.'s are designed to please engineers, inventors, executives, small boys, mothers, brothers and distant cousins. Coil power, shock mountings and circuit connections can be forgotten; 1932's are above all that. Their usefulness is their ability to provide *basic* pleasures, free of psychological complications or additional investment. For example, you can easily carry a 1932 around in your pocket, ready for instant use in any conversation . . . or just to remind yourself that *you* are part of today's World of Electronics. Or a certain Technical Atmosphere can be created by casually placing a 1932 on your desk, living room mantelpiece or bar counter—wherever *you* happen to be. (This quality will undoubtedly have immediate appeal to executives of advertising agencies with technical accounts.) And for plain utility, a 1932 WPA G.R. with its removable base is handy for carrying pills, parking meter money, rare emeralds, BB gun pellets, secret messages printed on bible paper, truth serum and other small items of everyday usefulness. (It is not recommended that alcohol be placed in a 1932; it could eat the genuine finish; besides, it only holds 0.379 oz.)

If you hurry, you can get a Sigma GIFTRELAY for *that* person; if you don't hurry, you'll still probably be able to get one but we'll be disappointed. Send 25 cents in hard cash or mint stamps (no rare coins *this* time, please), to L. B. Quinlan, Adv. Mgr. Offer closes sometime and all decisions of the shipping room are final.



MODEL 1932 GIFTRELAY, actual size; outwardly similar to Sigma Series 32; inside, there ain't nuthin'.

SIGMA

SIGMA INSTRUMENTS, INC.

62 Pearl St., So. Braintree 85, Mass.

AN AFFILIATE OF THE FISHER-PIERCE CO. (Since 1929)

receive signals from a synchro control transformer, or similar signal device, and to provide a quadrature suppressed signal to an a-c servo amplifier such as those in the TRAMP line produced by the company. **Circle 320 on Reader Service Card.**

Sound Source wide band

B&K INSTRUMENTS, INC., 3044 W. 106th St., Cleveland 11, Ohio, announces a new, quick and reliable instrument for field calibration of sound measurement systems. It is specifically designed to be used with standard measurement microphones. Model 4240 noise source is a small, self-contained acoustic calibrator for quick and reliable calibration of sound measurement systems. It mechanically generates a wide band sound at a sound pressure level of approximately 108 db for about 14 sec by means of 14,000 1-mm precision steel balls striking a metal diaphragm. The spl is calibrated in terms of its rms value and is accurate to ±1 db. **Circle 321 on Reader Service Card.**

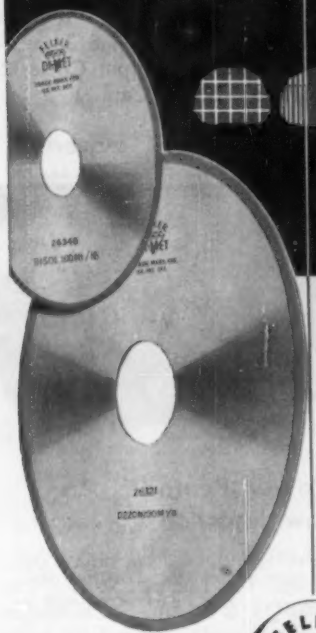
Servo Amplifiers

400-cycle units

LIBRASCOPE, INC., 808 Western Ave., Glendale, Calif., announces the model 501-2 transistor servo amplifiers. With a ¾-w output, the light-weight (less than 2 oz) encapsulated units use silicon transistors to provide reliable performance over wide temperature range. Particularly suited for controlling small servo motors in high-performance instrument control systems, they have a voltage gain of 100, with an

You can reduce
GERMANIUM WASTE

with these new paper-thin
Felker Diamond Blades!



Here's good news to *all* crystal cutters, germanium, quartz, silicon, barium titanate, etc.! Felker DI-MET metal bonded diamond blades are exceedingly thin, *greatly reducing amount of expensive crystal lost in the cut!* Special blades are supplied for either wafering or dicing insuring maximum efficiency and savings of material!

Fast cutting, smooth finishes, long blade life, utmost reliability... you get them all in Felker DI-MET... originators of the first commercial diamond abrasive cut-off blades!

Available from your Felker Distributor... or write direct.

Above: **FOR DICING TYPE DIT** Available as thin as .006"

Below: **FOR WAFERING TYPE DITR** Available as thin as .015"

FELKER MANUFACTURING CO.
Torrance, California

First in Diamond Cut-Off Blades!

CIRCLE 209 READERS SERVICE CARD

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FUSED QUARTZ MEETS YOUR CRITICAL REQUIREMENTS

CHECK WHAT VITREOSIL OFFERS:

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VITREOSIL fused quartz products can be supplied in an unusually large variety of types and sizes. Also fabricated to specification to meet semi-conductor requirements.

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For ultra-violet applications, metallurgical investigations and processes, chemical research and analysis, photochemistry, spectroscopy and physical, optical and electrical research and production operations. Send specifications for your requirements. Please use coupon below.

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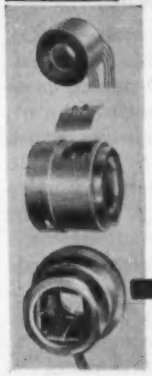

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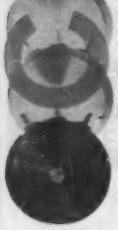
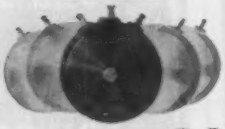
SHOCK



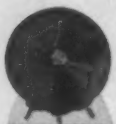
The T takes 50G's meeting MIL-R-19; exceeding NAS 710 proc. III

VIBRATION



The T takes 500 cps at 30G's, meeting NAS 710 proc. III

ACCELERATION



The T takes 100G's, exceeding MIL-R-19

TEMPERATURE

The T takes −55° to +125°C, with 1.2 watts at 40°C

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and you'll find the Helipot Series T all-metal single-turn precision potentiometer can take it!

Name your linearity, to ±0.20%...your resistance, from 650 to 100,000 ohms...up to 5 ganged sections and 9 taps per section...servo or bushing mount, with bearings front and rear for perfect alignment.

Put them all together, in the T's new cup-type housing, and you'll have the best-value miniature you can design into your system!

For the full T-Pot Story, whistle for data file A122.

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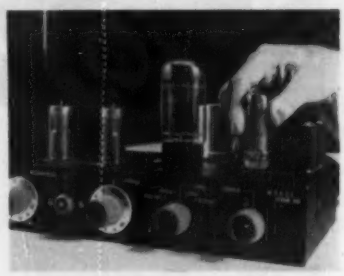
Helipot Division of Beckman Instruments, Inc.
Fullerton, California
Engineering representatives in 28 cities

potentiometers : dials : delay lines : expanded scale meters : rotating components : Breadboard parts

1870

input impedance of 100 K ohms. Power requirements are 28 v d-c at 60 ma for full output. **Circle 322 on Reader Service Card.**



Power Pentode low-distortion

WESTINGHOUSE ELECTRIC CORP., Route 17, Elmira, N. Y. The 6/8BQ5 is a nine-pin miniature power pentode intended for audio output with limited driver voltages. As a Class A amplifier the tube will deliver 5.7 w with a maximum of 10 percent distortion; in Class AB pushpull operation, it will deliver 17 w with a maximum of four percent distortion. Rated plate dissipation is 12 w. **Circle 323 on Reader Service Card.**

Oscillator-Transducer for high reliability

SOLID STATE ELECTRONICS CO., 8158 Orion Ave., Van Nuys, Calif., has available the Osciducer, an ultraminiature pressure-to-frequency converter which provides a new simplified approach to missile, space vehicle, aircraft and industrial telemetering. A temperature stabilized silicon transistor oscillator has been wedded to a variable inductance diaphragm-type pressure transducer to provide a complete in-line instrumentation module for the remote measuremen

pressure. **Circle 324 on Reader Service Card.**

Adhesive Tape
pressure sensitive

DURABLE RUBBER PRODUCTS CO., 609 W. Lake St., Chicago, Ill., announces a double-faced pressure sensitive adhesive tape called Twin-Stick No. 9. It consists of a light weight, porous, transparent paper carrier which has been saturated and coated on both sides with a clear, aggressive, super-aging pressure sensitive adhesive. The rolls are available with a dry edge where the release paper overlaps the adhesive film by $\frac{1}{8}$ in. This allows for ease in removal of the release paper after applying to the surface. **Circle 325 on Reader Service Card.**

Gas Density Switch
subminiature

NEWARK CONTROLS CO., 15 Ward St., Bloomfield, N. J. Model RM-73 subminiature gas density switch was designed for use on aircraft, missiles, vibrating equipment, wave guide, x-ray machines, and packaged electronic equipment. Units are used to detect gas leakage in closed volumes where the normal gas pressure varies with temperature; to detect critical arc-over gas densities; and to signal gas densities in processes that are subject to wide variations in temperature. **Circle 326 on Reader Service Card.**

Junction Transistor
pnp type

RADIO CORP. OF AMERICA, Somerville, N. J. A new germanium *pnp* alloy-junction transistor (2N-331) is announced. The 2N331

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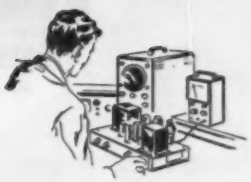

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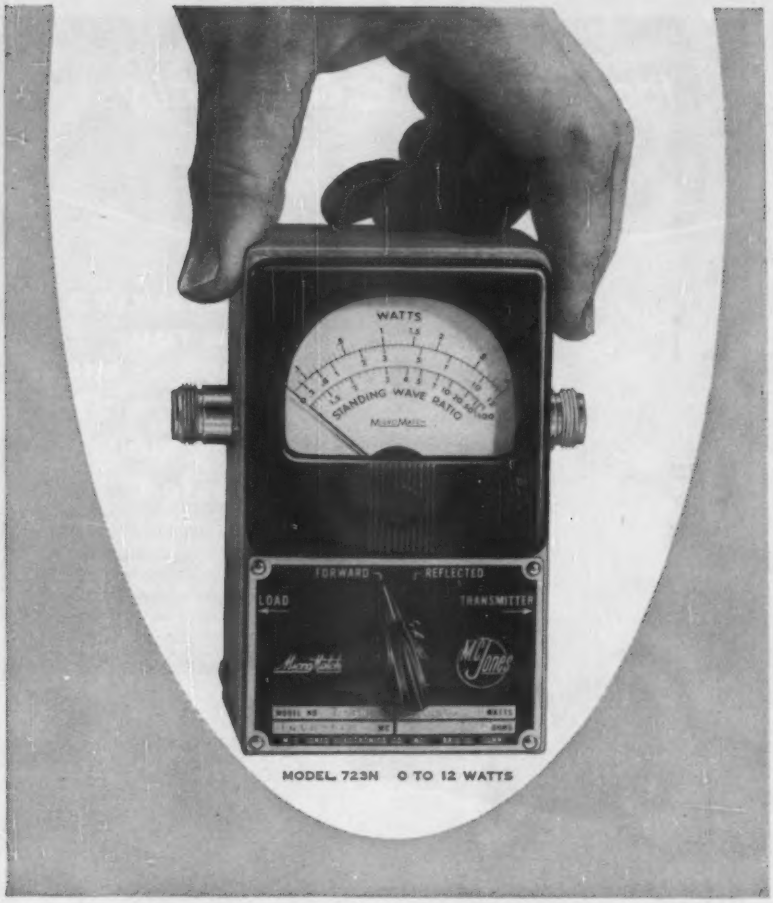

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25 MCS TO 3000 MCS

These rugged, compact units accurately measure and indicate the RF power and VSWR of coaxial transmission lines. Each type combines a frequency insensitive bidirectional coupler and complete indicator circuit in one small case. Accuracy of power measurement is ± 5% of full scale.

Model No.	Frequency Range (Mcs)	Power Range (Watts)	RF Connectors
712N	25—1000	0-2.5; 5; 10 in 3 scales	N*
723N	1000—3000	0-12 in one scale	N†

** Also available with UHF, BNC and Type C connectors*
† Also available with BNC and Type C connectors

For more information please write for 68-page catalog No. 12 or see Electronics Buyers' Guide or Electronic Engineers Master.

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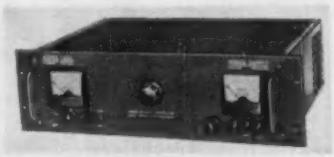
M.C. JONES ELECTRONICS CO., Inc.
BRISTOL, CONNECTICUT

has a current-transfer-ratio characteristic which is essentially constant over the useful operating current range for the device. This feature, in addition to low collector-and emitter-cutoff currents, low base resistance, a typical power gain of 44 db, and a typical noise factor of 9 db, makes the new transistor particularly useful in low-power a-f amplifier service. Transistor is hermetically sealed in a metal case having the dimensions of JETEC outline No. TO-9. **Circle 327 on Reader Service Card.**

Shielded Coil Form horizontally mounted

Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass., announces a completely shielded coil form assembly using internal powdered iron components of unique design. It is ideal for i-f strip work where ease of tuning, compactness, and dependability under rigorous service conditions are required. The assembly can be chassis mounted for conventional circuitry by means of a No. 2-56 screw or it can be mounted for p-c wiring by four pins. Required mounting holes are on 0.400 in. by 0.300 in. centers. The mounted assembly is ½ in. wide by ½ in. high. **Circle 328 on Reader Service Card.**



V-R Power Supply magnetic type

Kepco Laboratories, Inc., 131-38 Sanford Ave., Flushing 55, N. Y.

Model KM-253 compact tubeless magnetic voltage regulated power supply delivers in two ranges, 20 to 40 v, 0 to 6 amperes, and 40 to 60 v, 0 to 4 amperes. Regulation for line or load is less than ±1 percent. Ripple is less than 0.05 percent. Other features include high conversion efficiency 75 percent at full load, a control for optimizing regulation at any given output voltage, excellent resolution, short circuit and overload protection, excellent line transient response. **Circle 329 on Reader Service Card.**

Voltage Regulators for critical control

General Electric Co., Schenectady 5, N. Y. Changes in load power factor, supply power frequency or load do not affect the operation of the Inductrol voltage regulators. For industrial and military applications requiring critical, drift-free voltage control, these units of dry-type construction are available in standard ratings up to 600 v, 240 kva, single-phase, and 600 v, 720 kva, three phase. **Circle 330 on Reader Service Card.**

Glass Fabric in roll form

Standard Insulation Co., East Rutherford, N. J. Stanpreg Pl, a new all-purpose polyester resin preimpregnated glass fabric, combines unusually high elevated temperature strengths with flame resistance. Laminates prepared from Stanpreg Pl are rated as self-extinguishing and have retained approximately

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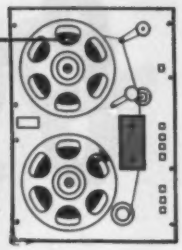
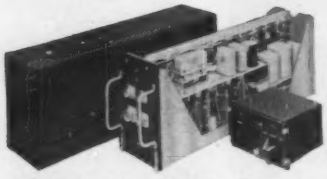


IN ANALOG DATA REDUCTION SYSTEMS

Three companion units by Hycon Eastern provide automatic indexing and high-speed access to selected data in multi-channel magnetic tape instrumentation systems.

For Tape Indexing

DIGITAL TIMING GENERATOR, MODEL 201, generates numerically coded timing signals which are recorded on magnetic tape throughout the data recording periods, providing a precise digital index in terms of elapsed time. The Generator also visually displays the exact time in hours, minutes and seconds as illuminated digits.

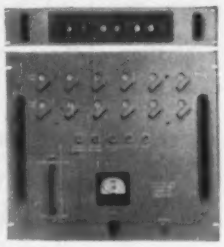


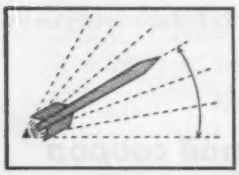
DIGITAL TIMING GENERATOR, MODEL 206A, FOR AIRBORNE APPLICATIONS is a militarized version of Model 201. A Remote Control Box contains Power off-Standby-Operate Switch, the Digital Clock Set, and the Time Display. Completely transistorized, Model 206A includes a binary coded decimal system although other timing formats are available to meet customer requirements. Weighing only 15 pounds, Model 206A is stable to 1 part in 100,000 giving an accuracy of ± 1 second in 1 day's time.

WESCON SHOW
Booth Nos. 1565 & 1566

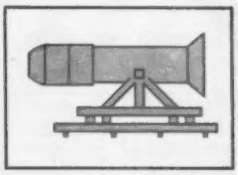
For Tape Search

MAGNETIC TAPE SEARCH UNIT, MODEL 202, operates during data reduction periods. On the basis of time indices recorded on the tape by the Digital Timing Generator, this instrument automatically locates and selects for controlled playback the tape data included between a "sequence start time" and a "sequence end time" specified by panel dial settings. The time index is visually displayed as illuminated digits on a small separate panel which may be remotely located for convenience. Model 202 may be modified to search for timing formats other than those originated by Model 201.

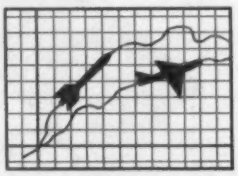




WIND TUNNEL TESTING
Pressure and temperature data of missiles are referenced to angle of attack. Model 201 records on tape a digitized position signal for each new angle of attack.



JET ENGINE TESTING
Digital Timing Generator, Model 201 synchronizes all data receiving equipment. Its output can be piped to multiple test cells and control rooms simultaneously.



MISSILE AND AIRCRAFT TESTING
Model 206A generates timing signals simultaneously with other flight test data. Model 201 generates a timing code format for synchronizing ground station recordings.

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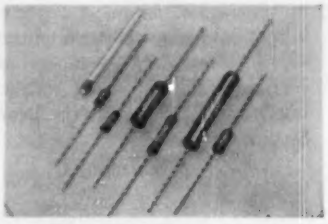
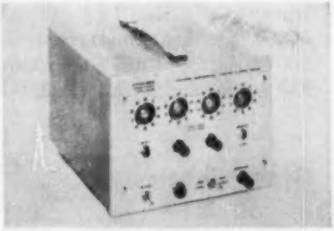
50 per cent of their original values at operating temperatures up to and including 400 F for periods as long as 200 hours. It is an ideal material for both commercial and military applications. **Circle 331 on Reader Service Card.**



Power Resistors axial-lead

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass., has introduced tiny 2 and 2½-w vitreous-enamel power wirewound resistors as part of a new series of its axial-lead Blue Jacket resistors for industrial applications. The 2-w resistor is only ⅞ in. in diameter by ⅜ in. long, while the 2½-w resistor is only ⅞ in. in diameter by 17/32 in. long. Other ratings in the series include a 3-w, a new and smaller 5-w unit, and new-7 and 11-w resistors in the sizes of the previous 5 and 10-w units. A complete list of standard ratings available in a variety of resistance tolerances is shown in engineering bulletin 7410, available on letterhead request.



Interval Timer highly accurate

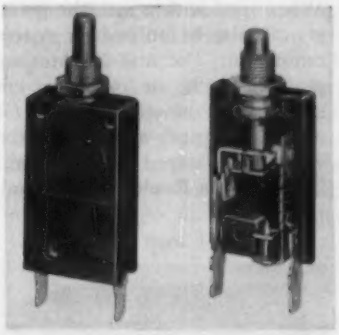
DYNAPAR CORP., 5150 Church St., Skokie, Ill. The Dynatimer Electronic Stopwatch has been developed for measuring time intervals between opening and closing of contacts on virtually any instru-

ment or control. It is available with either glow counter tube or Nixie neon tube readout, for direct numerical reading in milliseconds. Accuracy is ± 1 millisec; range, contact time intervals from 2 millisec to 10 sec. Several time intervals may be automatically totaled. **Circle 332 on Reader Service Card.**

Epoxy Adhesive

in stick form

ROBERT MARKS CO., 47 Goddard St., Providence, R. I. Epistik, a new epoxy adhesive in stick form, is as simple to use as a stick of sealing wax. Simply heat parts to about 225-250 F, rub stick on parts, then assemble and cure at once, or let parts cool and assemble and cure at any time. It bonds all types of metals, ceramics, carbides, and carbon to each other or themselves. Any material that can withstand curing temperature of 260 F can be bonded. **Circle 333 on Reader Service Card.**



Circuit Breaker

miniature device

E-T-A PRODUCTS CO. OF AMERICA, 6284 N. Cicero Ave., Chicago 46, Ill. Model 45-700-P miniature circuit breaker eliminates nuisance or accidental circuit interruptions. The trip-free mechanism prevents breaker reset while overload conditions prevail. Depression of the reset button will not interrupt the circuit once the breaker is closed. Unit can be installed singly or in banks and will cope with surge cur-

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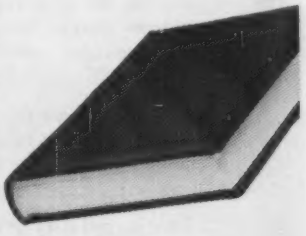

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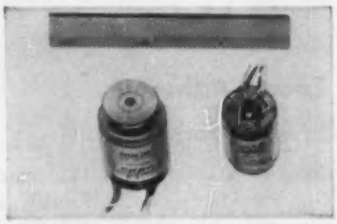
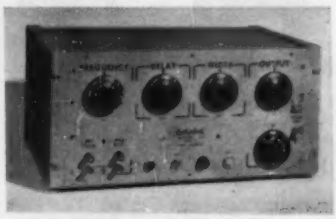
rents up to five times rated current. It will carry continuous current at an ambient temperature of + 68 F. Models are available with ratings from 0.05 to 25 amperes. **Circle 334 on Reader Service Card.**



Synchros pointer shows EZ

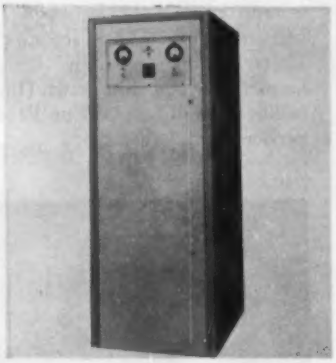
CLIFTON PRECISION PRODUCTS CO., INC., 9014 West Chester Pike, Upper Darby, Pa. To aid the design engineer in breadboarding synchro systems, the company now furnishes synchros and resolvers with a pointer visible through a small window at the rear of the shaft. The engineer can tell at a glance if his system is properly phased by watching rotation of the pointers. When used with a dial, the pointers can also be utilized for system calibration. The new synchros are provided with an integrally cut gear on the mounting flange for setting electrical zero while the synchro is clamped in the system. **Circle 335 on Reader Service Card.**



Pulse Generator high speed unit

RUTHERFORD ELECTRONICS CO., 8944 Lindblade St., Culver City, Calif. Model B-7 pulse generator provides repetition rates from 20 cps to 2 mc from an internal oscillator, pulse widths from 0.05 μsec to 1,000 μsec, and pulse delays from 0 to 10,000 μsec. The instru-

ment may be triggered externally. The output pulse has an amplitude of 50 v either positive or negative into a load of 50 ohms. The rise and fall time is 0.02 μsec. Duty factor of the output pulse is 25 percent. **Circle 336 on Reader Service Card.**



Power Supply for ground support

PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif., has developed a 24-32 v at 500 ampere magnetic amplifier-transistor regulated militarized d-c power supply for missile ground support applications. Model M1134B has an a-c input of 208 v, ± 10 percent 3 phase, 60 cycle. Static regulation is ± 20 mv for line changes, and 20 mv for load changes no load to full load. Dynamic load regulation is ± 5 v for a no load to full load, or full load to no load change. Ripple is less than 150 mv rms.

Chopper Transformers meet MIL-T-27A specs

UNITED TRANSFORMER CORP., 150 Varick St., New York 13, N. Y., has added two chopper transformers to its hermetically sealed audio

ALLIED'S NEW ADDITIONS TO THE
KH SUBMINIATURE LINE

Types KHJ and KHY
GENERAL FEATURES:

Contact Data:
Contact Arrangement—DPDT
Contact Rating—
Low-level up to 2 amps at 29 volts d-c, 1 amp at 115 volts a-c 400 cps non-inductive or 0.5 amp inductive.
Life—100,000 minimum at 125°C
Also available 3 amps at 29 volts d-c 2 amps at 115 volts a-c 400 cps non-inductive or 1 amp inductive.
Life—100,000 at 3 amps or 500,000 minimum at 2 amps at 125°C
Initial Contact Resistance—0.05 ohms maximum
Contact Drop—1 millivolt maximum at low level rating, initial and during low level mike test.

Operate Data:
D-C Coil Resistance—up to 10,000 ohms
Nominal Power—1.2 watts
Pull-in Power—240 milliwatts (standard)
100 milliwatts (special)
Operate Time—5 milliseconds max.
Release Time—3 milliseconds max.

Dielectric Strength:
1000 volts rms at sea level
500 volts rms at 70,000 feet
350 volts rms at 80,000 feet

Insulation Resistance:
10,000 megohms minimum at 125°C

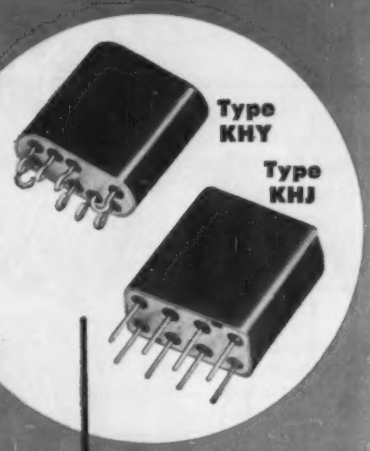
ENVIRONMENTAL FEATURES

Vibration:
5 to 10 cps at 0.5 inch double amplitude
10 to 55 cps at 0.25 inch double amplitude
55 to 2000 cps at 20 g
Shock: 100 g's operational • 200 g's mechanical
Ambient Temperature: —65°C to +125°C

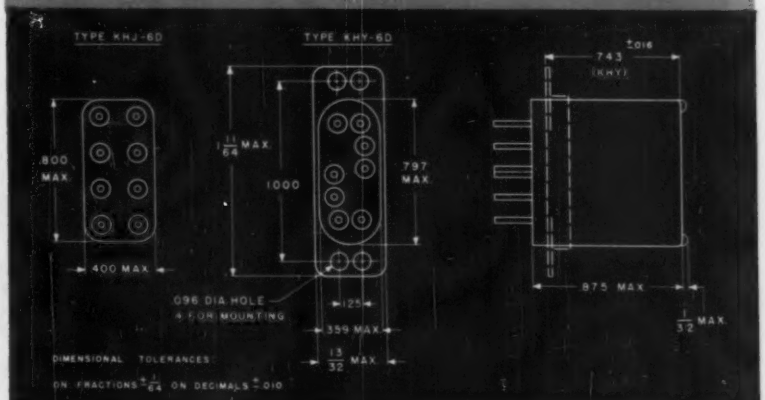
MECHANICAL FEATURES

Weight: 0.3 ounce
Terminals:
Hooked Solder • Plug-in • Printed Circuit
Mountings:
2 or 4 hole brackets at base or center of gravity
1 or 2 studs on top or side of housing

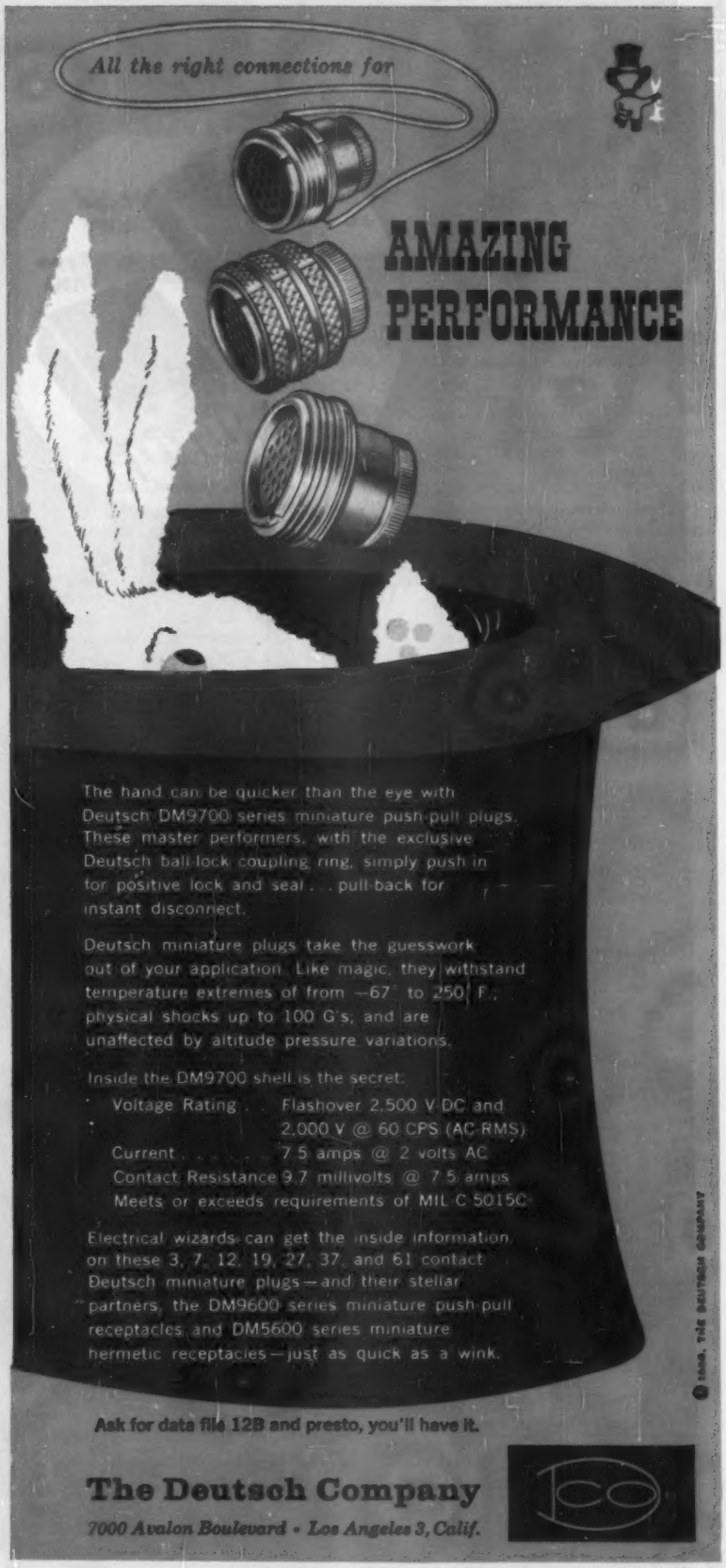
MILITARY SPECIFICATIONS
MIL-R-25018 • MIL-R-5757C



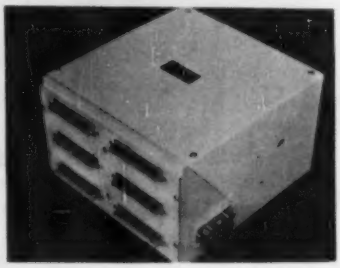
Allied's type KHJ and KHY subminiature relays have a higher contact rating than Allied's original subminiature relay and are designed to meet the increased vibration and shock requirements of the latest MIL specs. In addition, the type KHJ relay has incremental grid spaced terminals for application to "Automation" assembly. Both relays are available with brackets for mounting interchangeable with that of Allied's type KH subminiature relay.



ALLIED CONTROL
ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

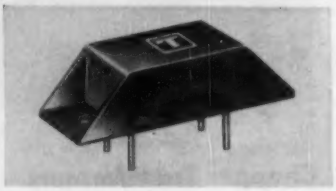

All the right connections for
AMAZING PERFORMANCE
The hand can be quicker than the eye with Deutsch DM9700 series miniature push-pull plugs. These master performers, with the exclusive Deutsch ball-lock coupling ring, simply push in for positive lock and seal . . . pull back for instant disconnect.
Deutsch miniature plugs take the guesswork out of your application. Like magic, they withstand temperature extremes of from −67° to 250° F., physical shocks up to 100 G's, and are unaffected by altitude pressure variations.
Inside the DM9700 shell is the secret:
Voltage Rating . . . Flashover 2,500 V DC and 2,000 V @ 60 CPS (AC RMS)
Current . . . 7.5 amps @ 2 volts AC
Contact Resistance 9.7 millivolts @ 7.5 amps
Meets or exceeds requirements of MIL-C 5015C
Electrical wizards can get the inside information on these 3, 7, 12, 19, 27, 37, and 61 contact Deutsch miniature plugs—and their stellar partners, the DM9600 series miniature push-pull receptacles and DM5600 series miniature hermetic receptacles—just as quick as a wink.
Ask for data file 12B and presto, you'll have it.
The Deutsch Company
7000 Avalon Boulevard • Los Angeles 3, Calif.

line. Units fully meet MIL-T-27A specifications and are suited to both military and industrial application. The H-290 employs electrostatic shielding and triple magnetic shielding, and provides a ratio of 1:6.4 (2,500 ohm half primary to 100 K secondary). The H-291 provides an additional 20 db shielding and higher gain with a ratio of 1:25/1215 (2,000/500 half primary to 312 K secondary). Units are high reliability designs hermetically sealed in drawn Hipermalloy cases. **Circle 337 on Reader Service Card.**



Sampling Switch high-speed unit

General Devices, Inc., Box 253, Princeton, N. J., has available a high-speed sampling switch newly designed for sequential drift stabilization of up to 83 high gain d-c amplifiers. Model 108A has two poles, 170 contacts per pole, or 85 non-shorting channels per pole and a removable cover which permits easy inspection while in operation. It is compact in structure, being only 10 in. wide by 10.38 in. long by 6.31 in. high and the entire assembly is made in plug-in form. **Circle 338 on Reader Service Card.**



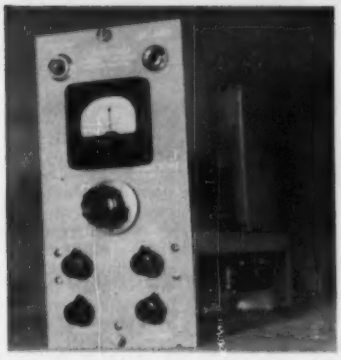
Reference-Amplifier combined package

Transitron Electronic Corp., Wakefield, Mass. A new device

combines in a single package a voltage reference (temperature compensated zener diode) and an amplifying transistor. The Ref-Amp provides a combined temperature coefficient as low as 0.002 percent per deg C over a temperature range of −55 C to +100 C. Regulator circuits, normally requiring 10 or more components, may now be designed with only one transistor, one Ref-Amp, and four resistors. **Circle 339 on Reader Service Card.**

Teflon Tape
high stability

JOCLIN MFG. CO., Wallingford, Conn., announces a new type of Teflon tape with pressure-sensitive silicone adhesive and superior bondability and stability under extreme conditions. Layer upon layer of sub-micron sized particles of Teflon are fused together to build up film thicknesses from 0.00025 to 0.005 in. By virtue of the multiple dipping process, the film is free from pinholes and blemishes, with new high mechanical, chemical and electrical properties. Fluorolin 600 has many applications in the electronic, aircraft and electrical industries. **Circle 340 on Reader Service Card.**



Noise Instrument
broad band

CHESAPEAKE INSTRUMENT CORP., Shadyside, Md., has developed the Detector-Integrator for use in the measurement of random noise over the range of frequencies from 10 cps to 50 kc with a dynamic range of better than 50 db. Linear opera-

Accurate

*These tolerances are from absolute frequency under any combination of the conditions within operating specifications. For specific operating conditions much closer frequency tolerances may be maintained.

TRANSISTORIZED
TUNING FORK

FREQUENCY STANDARDS

TYPE MAFC — Frequency Standard
- Frequency Range Available: 360 cps to 4 kc
- Tolerances % ±: 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Ranges: —20 to +71°C, —55 to +100°C, —55 to +125°C
- Power Supply Voltage: 12 or 28 vdc ± 15%
- Size: 1⅜"x1⅝"x2¼" • Weight: 8 oz.

TYPE AFC — Frequency Standard
- Frequency Range Available: 360 cps to 4 kc
- Tolerances % ±: 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Ranges: —20 to +71°C, —55 to +100°C, —55 to +125°C
- Power Supply Voltage: 12 or 28 vdc ± 15%
- Size: 2⅛"x2⅛"x3¼" • Weight: 13 oz.

TYPE MAFCD — Frequency Standard
- Frequency: 60 cps
- Tolerances % ±: 0.2, 0.05, 0.02, 0.01, 0.005*
- Temperature Range: —55 to +71°C
- Wave Shape: Sine w/less than 1% harmonic distortion
- Power Supply Voltage: 10 to 14 vdc
- Size: 4⅛"x4⅛"x4⅛" • Weight: 4 lbs.

TYPE MFB — Frequency Divider
- Ratios Available: 2:1, 4:1, 5:1, 8:1, 10:1, 16:1
- Temperature Ranges: —20 to +71°C, —55 to +100°C
- Power Supply Voltage: 12 or 28 vdc ± 15%
- Size: 1⅜"x1⅝"x2¼" • Weight: 6 oz.

TYPE MFS — Frequency Standard for Laboratory or Field

Type MFS is a small, lightweight frequency standard that can replace units many times its size without sacrificing frequency stability. Internal batteries and provisions for external power supply make the unit ideal for either laboratory or field applications.
- Frequency Ranges Available: 50 cps to 4 kc
- Frequency Stability: 2 parts in 10^9/per month
- Temperature Range: —20 to +71°C
- Size: 3⅞"x5¾"x5¾" • Weight: 2 lbs.

TYPE MLS — Laboratory — Frequency Standard

Type MLS is an extremely high stability laboratory frequency standard. The clock on the panel facilitates easy checking of stability.
- Frequency Ranges Available: 50 cps to 4 kc (Multiple Taps Optional)
- Frequency Stability Available: 5 parts in 10^7
- Output: 10 watts at specified frequency
- Input: 115 v, 50 cycles to 400 cycles
- Size: 9"x10"x7" • Weight: 15 lbs.

A wide variety of units are designed to comply with the most severe military specifications.

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HOUSTON 6, TEXAS
JA 3-2712

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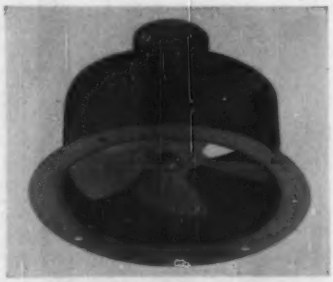
tion results in output proportional to average value of input. Plug-in features make the units well suited to noise analysis systems. In general, the instruments readily lend themselves to applications where it is desired to produce an output that is an integral of the input. **Circle 341 on Reader Service Card.**

H-V Supply transistorized

COMPONENTS CORP., Denville, N. J. Model 59 transistorized miniature h-v supply operates from 6 v d-c and its outbut can be adjusted from 1,000 to 1,500 v d-c. It is ideally suited for use in portable health hazard instrumentation devices requiring high voltage at low current —such as photomultiplier tubes, geiger muller tubes and other gas filled detectors. **Circle 342 on Reader Service Card.**



Axial Blower for panel cooling

AIR IMPELLER DIVISION, The Torrington Mfg. Co., Torrington, Conn. A series of tubeaxial blower units has been designed specifically for cooling electronic panels in computers, radio and tv broadcast units, military electronic equipment, and other communications systems. The basic blower unit is

- Small size
- Reduced cost
- Long life
- Friction reduction
- Corrosion resistance
- Dry operation
- Non-magnetic material

BIG REASONS WHY

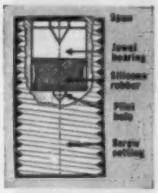
Bird PRECISION JEWEL BEARINGS MEAN BETTER INSTRUMENT PERFORMANCE

In today's miniaturized instrumentation Bird Sapphire and Glass Jewel Bearings show their unique properties to best advantage . . . dry operation through temperature extremes . . . resistance to corrosion fumes and liquids . . . adaptability to special mounting arrangements.

Bird Complete Jewel Assemblies

. . . save time and money, cut rejects, keep production flowing smoothly. Special mounting techniques provide assemblies in screws or bushings of any style.

Bird Cushion Jewel Assemblies



. . . add shock protection to any instrument for only pennies. Variable cushioning of silicone rubber controls movement, eliminates waste due to poor bearing adjustment in mounting.

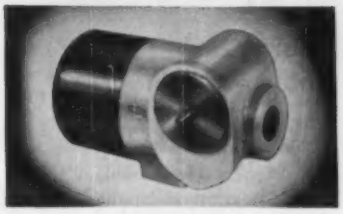
Compared with other types of bearings Bird Jewels are substantially more economical and their long life expectancy eliminates maintenance problems.

NEW CATALOG AVAILABLE

. . . a complete description of properties and uses of jewel bearings for aircraft, electrical and timing instruments, recorders and indicators. Write for your copy.

Richard H. Bird & CO., INC.
1 Spruce Street, Waltham, Mass.
Serving Industry With Fine Jewels Since 1913
CIRCLE 223 READERS SERVICE CARD

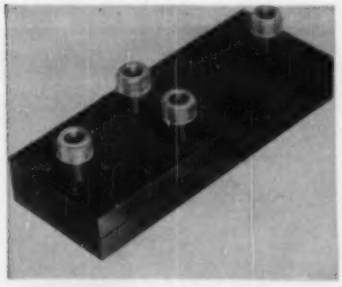
6 in. in overall diameter, 4 in. long, weighs 16 oz, and can deliver from 50 to 160 cfm. Variations in unit size and air output can be made, and the motor may be either a-c or d-c. **Circle 343 on Reader Service Card.**



Electric Motors

fractional h-p

CARTER MOTOR CO., 2762A W. George St., Chicago, Ill., announces a new line of Ecliptic precision built fractional h-p electric motors. They are made in a dozen or more models of 1/1,000 to ¼ h-p capacity. Sizes range upwards from 1¼ in. diameter, 2¼ in. lengths, and weights from 7 oz up. **Circle 344 on Reader Service Card.**



Coax Bar Hybrid

for broadband use

BOGART MFG. CORP., 315 Siegel St., Brooklyn 6, N. Y. Model NL5805 is a highly versatile component used as a power splitter for broadband (900-1,500 mc) aircraft antenna applications. Power applied to one arm (transmitter), will divide equally between two other arms matched to 50 ohms or otherwise having the same degree of mismatch. If the output arms both have vswr values of 2/1, they would then receive equivalent power re-

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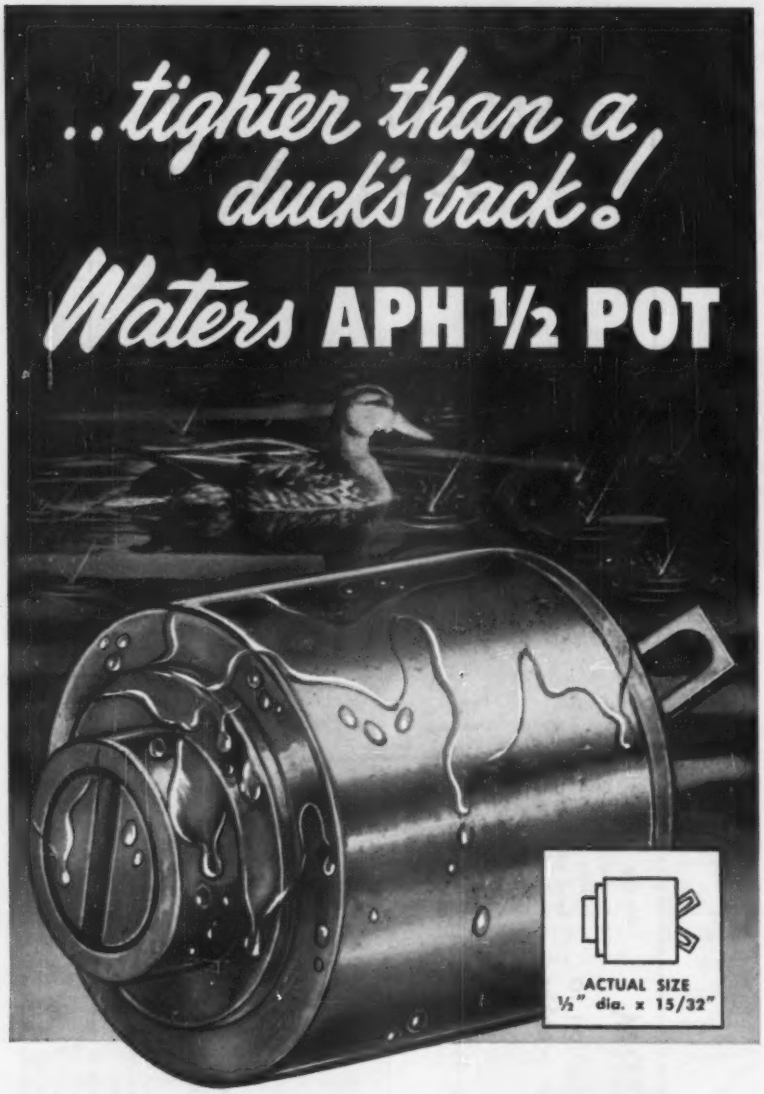


This new APH ½ Hermetical Seal Precision Potentiometer has been proven by Mass Spectrometer, "Radiflo" and other rigid leak detection tests.

Why pay extra for epoxy encapsulation, when Waters seals both ends of the APH ½ so tight that leakage is reduced as close to zero as you need. Its *"O" ring shaft seal* dams out moisture and salt spray. Its *glass-to-metal* seal minimizes leakage at the terminal lugs. Its *pre-tinned flange* eases air-tight soldering into the panel.

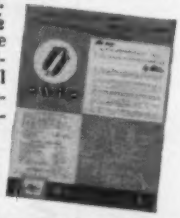
It's a "hot" pot, too! APH ½ derates to zero watts at 150°C. 1½ watts may be dissipated at 125°C. . . . 4 watts at 80°C.

Resistance range is from ½ to 100,000 ohms with a tolerance of ±5%.

Linearity tolerance is ±3% . . . tighter on request.

Meets military specifications: MIL-E-5272A, MIL-R-19, MIL-STD-202 and others as applicable.

Bulletin APH ½ gives you complete details about standard and optional electrical and mechanical specifications. Write:



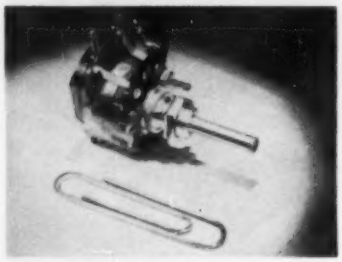
Waters MANUFACTURING, INC.

® BOSTON POST ROAD, WAYLAND, MASSACHUSETTS

gardless of the phase of the mismatch, since one of the properties of this hybrid is that isolation exists between opposite arms. The fourth arm of the hybrid is terminated in a matched load. **Circle 345 on Reader Service Card.**

Shaft Converter analog-to-digital

DATA INSTRUMENTS Division of Telecomputing Corp., 12838 Saticoy St., N. Hollywood, Calif. A new low-friction analog-to-digital shaft converter provides direction-sensing combined with high rate of pulse output. The accurate, shaft rotation measuring device consists of a magnetic reading head, and a group of associated equipment which provides for a choice of output options. The converter shows change in shaft position as a series of pulses which accurately define position of the input shaft. It also indicates the direction of shaft rotation. Pulse rates as high as 60,000 per sec may be obtained. **Circle 346 on Reader Service Card.**



Potentiometer smaller than dime

CLAROSTAT MFG. CO., INC., Dover, N. H. Series 44 carbon potentiometer is rated at 0.2 w. It is intended primarily for space-saving assemblies, particularly transistorized circuits, portable radios, hearing aids and so on. It measures only 21/32 in. body diameter, by 23/64 in. deep, plus mounting bushing and ¼ in. long shaft. Standard ohmages of 25 K and 500 K with W tapers, but also in 200 ohms to 5 megohms linear, and 1,500 ohms to 2.5 megohms

tapered, on special order. Circle 347 on Reader Service Card.

Secondary Standard portable unit

WIANCKO ENGINEERING CO., 255 No. Halstead Ave., Pasadena, Calif. A new portable secondary standard type Q 3401 for calibration and direct parameter measurement is now available. Interchangeable plug-in units, accommodating gage, differential, and absolute pressures, provide an overall accuracy of 0.05 percent for ranges up to 2,500 psig, psid, or psia. Used with a remote pickup, it provides a single-channel f-m system, since it incorporates a precision f-m oscillator and an integral power supply. Circle 348 on Reader Service Card.

Time-Delay Relay fixed or adjustable

HEINEMANN ELECTRIC CO., 391 Plum St., Trenton 2, N. J., has developed a transistorized time-delay relay which employs a fully electronic timing system to achieve fast switching action, instantaneous reset, high timing accuracy, and full reproducibility of the time-delay period even during rapid recycling. Called the Trans-O-Netic, the

DU PONT REPORTS ON **FREON®** **SOLVENTS**

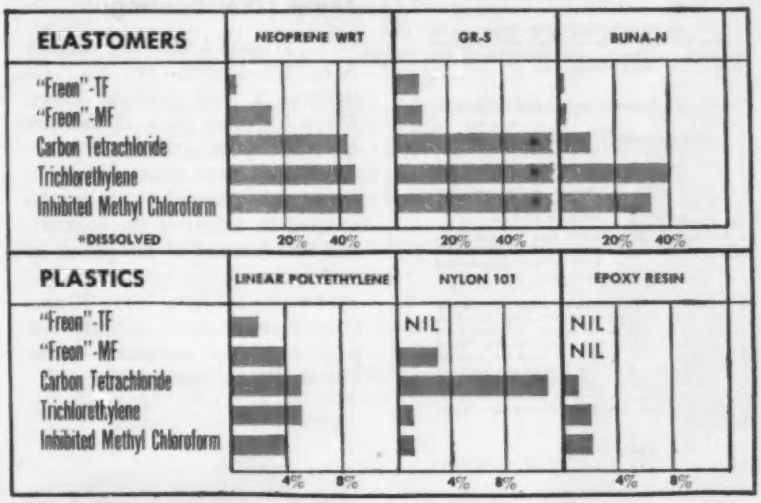
for precision-parts cleaning

New solvents by Du Pont clean with minimum effects to elastomer and plastic parts

Now you can protect delicate, costly parts during cleaning operations by using "Freon" solvents. For safe cleaning of precision parts and instruments, Du Pont's new "Freon" solvents remove oil and grease, yet show minimum effects on elastomeric and plastic materials.

Chart below compares linear swell of some commonly used plastics and elastomers due to "Freon" with that caused by other solvents. "Freon" cleans effectively, yet is noncorrosive without inhibitors, nonflammable, and much less toxic than ordinary solvents.

PERCENT LINEAR SWELL IN VARIOUS SOLVENTS (100 HRS. @ 130°F.)



NOTE: Swelling would be approximately nil in all cases with "Freon" solvents at their boiling points. Swelling would be considerably greater with all other solvents at their boiling points.

Freon† solvents minimize cleaning hazards. These new solvents by Du Pont offer outstanding safety for men and equipment. "Freon" is much less toxic than ordinary solvents—will not burn or explode. "Freon" is noncorrosive without inhibitors—is exceptionally stable even in the presence of oils and water. "Freon" solvents are suitable for a wide range of uses where ordinary solvents create problems of corrosion or damage to plastics, paint and elastomers.

For your free copy of Du Pont's booklet describing the unique properties of "Freon" solvents, mail the coupon or write: E. I. du Pont de Nemours & Co. (Inc.), "Freon" Products Division 5212, Wilmington 98, Del.

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†Freon is Du Pont's registered trademark for its fluorinated hydrocarbon solvents.

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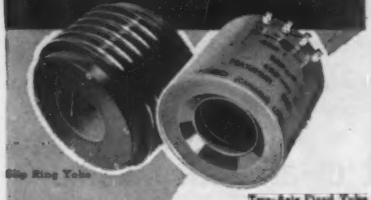


Slip Ring Yoke

Two-Axis Fixed Yoke

Component Development Engineering at its BEST!

- ADVANCED ELECTRICAL DESIGN
- PRECISION MECHANICAL DESIGN
- ACCURATE PRODUCTION METHODS

Custom Built to the most Exacting Specifications by Cossor Engineers

In Mumetal Cores for Optimum Geometry
In Ferrite Cores for Speed and Sensitivity
In Non-magnetic Cores for Perfection of Response

Any of Cossor's Three Core Types can be made in single or double axis with single or push-pull windings, and encapsulated for fixed or slip ring (rotating) use.

Normal characteristics of yokes for 1-1/2 in. neck tubes are:

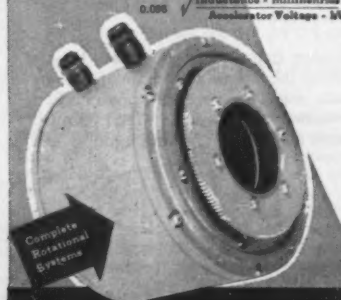
Positional accuracy - the spot position will conform to the yoke current co-ordinates within 0.25% of tube diameter. For deflection angles less than ± 25° better accuracy can easily be achieved.

Memory - 0.5% max. without overswing; 0.1% or less with controlled overswing.

Complete encapsulation in epoxy (stycast) or silicone resins is standard for all Cossor deflection yokes, and is done with special moulding tools ensuring accurate alignment of the yoke axis. When slip rings are added, solid silver rings are mounted in encapsulating resin. The finished slip ring yoke is precision turned to centre bore, and can include bearing mounting surfaces with dimensional tolerances approaching those associable with high quality metal parts.

Settling Time (Micro sec.) = $\frac{}{120 \sqrt{\text{Inductance in Henries}}}$

Sensitivity degree/ milliampere = $0.086 \sqrt{\frac{\text{Inductance - millihenries}}{\text{Accelerator Voltage - kV}}}$



COMPONENTS DIVISION
COSSOR
CANADA LIMITED

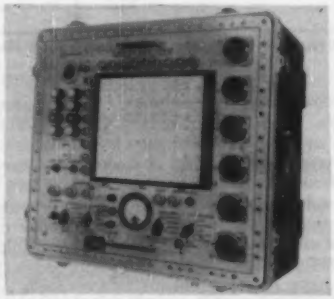
301 Windsor St., Halifax, N. S.
8230 Mayrand St., Montreal, Que.
648A Yonge St., Toronto, Ont.
Corporation House, 160 Laurier West, Ottawa, Ont.

CIRCLE 227 READERS SERVICE CARD

new relay uses a transistorized control circuit and a specially designed R-C network. It is available with either a fixed or adjustable time delay period of from 1.5 to 30 sec. Standard delay periods are 1.5, 5, 10, 15, 20 and 30 sec. **Circle 349 on Reader Service Card.**

Program Timer relay rack housing

G. C. Wilson & Co., 1915 Eighth Ave., Huntington, W. Va., announces a new program timer. Upon initiation by a momentary contact closure, a series of pulses (contact closures) occur. Any number of pulses from 1 to 30 may be selected by means of the controls, and the duration of the pulses, as well as the spacing between pulses, can be adjusted from 0.1 to 10 sec. Glow transfer tubes indicate the progress of the sequence. **Circle 350 on Reader Service Card.**

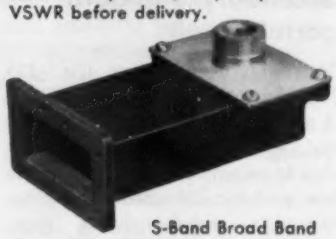


Circuit Analyzer shockproof unit

Dit-Mco Inc., 911 Broadway, Kansas City 5, Mo. The AN/USM-88 analyzer will accurately and automatically test every type of complex, multiple, interconnected circuitry for shorts, continuity and insulation flaws and also will func-

MICROWAVE SYSTEM COMPONENTS
Tested and Ready for Installation

Circularly Polarized X-Band Ridge Guide Antenna manufactured to specification and tested for pattern, ellipticity and VSWR before delivery.



S-Band Broad Band Coaxial To Wave Guide Adapter. VSWR 1.3 to 1, from 2250 to 4000 mc. One of many modifications available, this unit mates with RG-48/E Wave Guide and UG-532A/U Connector.

J-V-M Microwave Company can supply any type microwave component, including the most complex assemblies. All units are manufactured to your specifications and are delivered fully tested to the requirements of the particular application. Every possible measure is taken to insure optimum performance: close coordination from blue print to installation...availability of our complete engineering facilities ...personal assistance by our experienced staff of microwave specialists.

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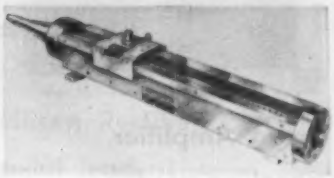
ENGINEERS AND BUILDERS OF ALL TYPES OF MICROWAVE COMPONENTS

CIRCLE 228 READERS SERVICE CARD

tionally test relays, solenoids, actuators and other resistive devices. This is done at the rate of approximately 10 circuits per sec. Defects are located and identified instantly by means of a visible matrix type reference chart. Circuit testing capacity is 144 circuits. **Circle 351 on Reader Service Card.**



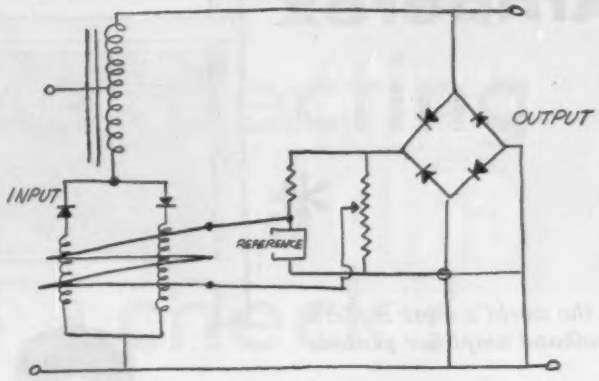
Slotted Line
low vswr

ALFORD MFG. CO., 299 Atlantic Ave., Boston 10, Mass. Type 1026 slotted line has a residual vswr under 1.01, and a rated error in detected signal under 1.005. Important surfaces on the outer conductor are hand scraped to fine tolerance. The inner conductor is supported by compensated dielectric pins. Type 1026 is furnished in lengths of 20, 40, 60, 80, and 130 in.; it is available in standard characteristic impedances of 50.0 and 75.0 ohms. **Circle 352 on Reader Service Card.**

Transistor Timer
high accuracy

AUTOMATIC TIMING & CONTROLS, INC., King of Prussia, Pa., announces a transistorized time delay relay for intervals from 50 millisec to 4.0 minutes for operation from external power supply of 40 v to 60 v, d-c at 0.050 ma maximum. Temperature range is −60 C to

MEET MIL SPEC E4970



SIMPLIFIED MAGNETIC AMPLIFIER REGULATOR

Meeting military specifications is practically an everyday occurrence at Raytheon. But each one has a special interest.

We thought you might be interested in how a magnetic-amplifier regulator met MIL SPEC E4970. The details are available to the more academically inclined. We will simply relate the results:

Service:	400 cycles
Power:	900 watts
Input:	95 to 125 volts
Output:	115 volts ±½%
Harmonic distortion:	±3%

The next time you have to meet military or your own rigid specifications, we'll be happy to go along.

Our slide rule and tuxedo are ready at a moment's notice. Simply contact:

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Raytheon Manufacturing Company
Magnetic Components Department
Section 6120
Waltham 54, Massachusetts

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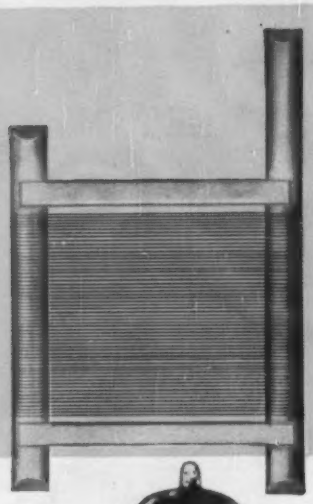
FRAME GRID*



... the world's most modern broadband amplifier pentode

Amperex 6688

a RELIABLE premium-quality tube for military systems requirements and exacting industrial applications

- completely ruggedized construction
- figure of merit of 250 Mc as broadband amplifier
- saves entire stages in IF and video amplifiers
- improves signal-to-noise ratio
- preferred for new equipment design, particularly airborne applications
- long-life cathode

TYPICAL OPERATION

Plate Supply Voltage	190 volts
Grid Supply Voltage	+9 volts
Cathode Bias Resistor	630 ohms
Plate Current	13 ma
Transconductance	16,500 μmhos (min. 14,200; max. 18,800)
Amplification Factor	50
Equivalent Noise Resistance	460 ohms
Grid Voltage (rms)	0.5 volt

* *It's the*

FRAME GRID CONSTRUCTION

that makes the difference!

The frame grid is the closest approach to the ideal "physicist's grid"— the grid with only electrical characteristics but no physical dimensions.

It results in:

- higher transconductance
- tighter G_m and plate current tolerance
- low transit time
- low capacitances
- lower microphonics
- rugged construction

Amperex FRAME GRID

The grid-to-cathode spacing tolerance is determined by the carefully controlled diameter of grid support rods (center-less ground) and by frame crossbraces between these rods. Extremely fine grid wire eliminates the "island effect" usually encountered in conventional tubes with equally close grid-to-cathode spacing. Rigid support of fine wires reduces mechanical resonance and microphonics in the grid.

CONVENTIONAL GRID

Grid-to-cathode spacing tolerance depends on accuracy of grid dimension, obtained by stretching on a mandrel, and on tolerances of holes in top and bottom mica rod supports. Diameter of grid wire must be large enough to be self-supporting.

Other **Amperex** Premium Quality (PQ) frame grid tubes available in production quantities:

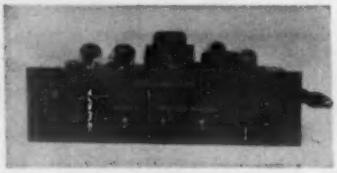
5847.....broadband amplifier pentode
6922.....ruggedized high-gain twin triode

plus other **PQ** *and frame grid tubes for special reliability requirements and exacting industrial applications*

ask **Amperex** ***about premium-quality tubes for special reliability requirements***

Semiconductor and Special Purpose Tube Division
AMPEREX ELECTRONIC CORP.
230 Duffy Avenue, Hicksville, L. I., N. Y.

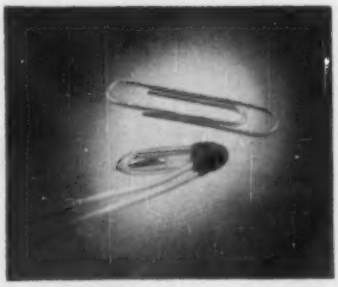
+100 C. Accuracy is ±4 percent over a supply voltage variation of ±10 v d-c. Repeatable accuracy is better than 1 percent for any time cycle. **Circle 353 on Reader Service Card.**



Servo Amplifier

panel-mounted

STERLING PRECISION CORP., 17 Matinecock Ave., Port Washington, N. Y. Model T861 servo amplifier is a panel-mounted self-contained module for driving turntable servomotor or motor generator. It has provision for tachometer damping besides straight proportional single channel. Provision is made for adding one or more channels for carrier or d-c lead and lag loop compensation. **Circle 354 on Reader Service Card.**



Mercury Switch

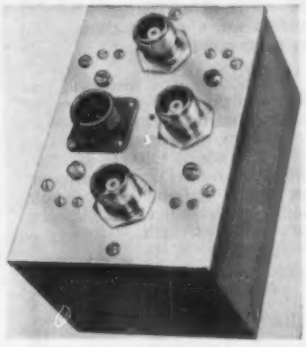
capsule-size

MICRO SWITCH, Freeport, Ill., has available a capsule-size mercury switch that weighs only 1.8 grams with leads attached. The tiny switch, which is claimed to offer sensitive, trouble-free operation, is designed for use in computers, scales, electronic organs and other devices where a minimum of operating energy is available and space is limited. The low shift of mass involved in actuation facilitates

gang-mounted assemblies. The switch, designated AS419A1, may be mounted in any position through 360 deg around its longitudinal axis. It may be actuated by slow, snap or fast-tilting action. **Circle 355 on Reader Service Card.**

Silicon Rectifier
axial lead

TRANSITRON ELECTRONIC CORP., Wakefield, Mass. A new h-v silicon rectifier series has operating characteristics up to 1,500 v and 100 ma at 150 C ambient temperature. The SL715 (100 ma) and SL615 (50 ma) are high temperature rectifiers combining very high voltage and current ratings with the convenience of axial lead mounting. This device may be used in power supplies for magnetrons, klystrons, electronic precipitators and other applications requiring 600 v output or higher. **Circle 356 on Reader Service Card.**



Coax Lobing Switch
miniaturized

THOMPSON PRODUCTS, INC., 23555 Euclid Ave., Cleveland 17, Ohio, announces model D18H2GA miniature coaxial lobing switch. Frequency range is 1,020-1,100 mc;

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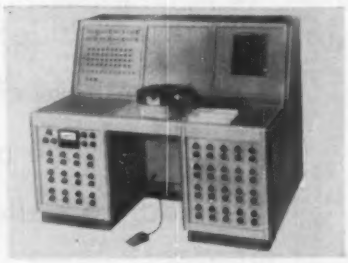
input vswr, 1.2 to 1 maximum; crosstalk, 21 db; insertion loss, 1 db maximum; switching rate, 20 cps (can be built for other switching rates). Unit measures 5⅞ in. wide by 3¾ in. high by 4¼ in. deep. Weight is 2¾ lb maximum. Life is 1,000 hr. **Circle 357 on Reader Service Card.**

D-C Control Motor rugged unit

ROTRON CONTROLS CORP., Woodstock, N. Y., announces an industrial d-c control motor constructed to withstand extra-severe service and abuse in adverse environmental conditions. It is designed as a building block for incorporation in control equipment and is available with an integral tachometer generator giving a 0 to 5 ma output signal linearly proportional to its speed. **Circle 358 on Reader Service Card.**



Transistor Tester high-speed machine

EDER ENGINEERING CO., 1568 S. First St., Milwaukee 4, Wisc. Model 2675, designed for automatic grading and sorting of transistors, handles up to 1,200 units per hr. It makes eight different tests of any one transistor type

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110 W. 11th ST., LOS ANGELES 15, CALIF.

CIRCLE 234 READERS SERVICE CARD

and is fail-safe in operation. The tester is hand-fed by a single unskilled operator, has automatic unload, and delivers the transistors into either accept or reject classification. It features a patchboard programming system, permitting the selection of any type d-c test and sequence. All test stations may be used individually or combined for a wide variety of d-c parameters. **Circle 359 on Reader Service Card.**

Microwave Analyzer wide dispersion

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y. Model TSA-W microwave analyzer permits complete visual analysis of extremely narrow to extremely wide microwave pulsed signals in the frequency range 10 to 44,000 mc. For analysis of pulses as short as 0.1 μsec, the analyzer provides frequency dispersion up to 70 mc. For wide pulse analysis, the instrument provides a narrower display bandwidth with extremely high resolution (7 kc). **Circle 360 on Reader Service Card.**

Servo Motors wide variety

SERVO DYNAMICS CORP., Somersworth, N. H., announces a complete line of miniature precision servo a-c motors of 60 and 400 cps in the frame sizes 8, 10, 11, 15, 18 and 23. The line includes damping generators, inertia damped motors, precision tachometer generators,

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It Pays to Standardize on Jeffers R.F. Choke Coils

You can save time, labor, and money by stocking the wide range of Jeffers R.F. choke coils just as you do resistors, capacitors, and other similar components. You can forget tedious, expensive hand assembly from miscellaneous forms, wires, and coatings by using standardized Jeffers coils, completely assembled for use.

Jeffers coils are well made, using insulated copper wire windings... husky molded jackets. All windings are soldered to leads... shorted end turns are completely eliminated.

Put these advantages to work in your circuits! Jeffers Electronics offers you . . . ready for delivery . . . a complete line of R.F. choke coils with a complete range of inductance values. Write today for our specification sheets.

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4027

THE NEW ACME 3-PART MIXTURE FOR IMPREGNATING AND MOLDING ALL ELECTRICAL WINDINGS

Now—an epoxy mixture that comes complete ready to mix and use. Nothing else to buy. Yet the cost is less than what is usually charged elsewhere for the resin alone! That's Acme Star Compound #4027.

This remarkable mixture is immediately self-extinguishing, even after repeated exposures to open flame. Cures hard and tough. Has excellent mechanical and thermal shock resistance. Viscosity low enough for thorough impregnation at process temperatures. Very good adhesion to metals and other materials used in coil construction. For data sheets, address your inquiry attention of G. F. Garrity, Divisional Sales Manager.

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MAGNET WIRE • COILS • VARNISHED INSULATIONS
INSULATING VARNISHES AND COMPOUNDS

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NEW! ENGRAVED Deep-Kut®

PIN & PEG STAMPS

are better than ordinary rubber 3 ways

- ENGRAVED *Deep-Kut* is Acid-Proof
- ENGRAVED *Deep-Kut* Stamping gives Razor-Sharp impressions every time
- ENGRAVED *Deep-Kut* has cushion-like resilience

Engraved Deep-Kut stamp faces are adaptable to any marking device. They can be used to stamp on every surface, metal, wood, fabric, paper, plastic, etc.

THE KRENGEL INSPECTION POCKET STAMP — THE PIN & PEG

KRENGEL MANUFACTURING CO., INC. *Tel.* CO 7-5714 — Dept. 3
227 Fulton St., New York 7, N. Y.

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FREE ENGRAVED Deep-Kut Sample & Price List ☐
Please have salesman call for appointment ☐

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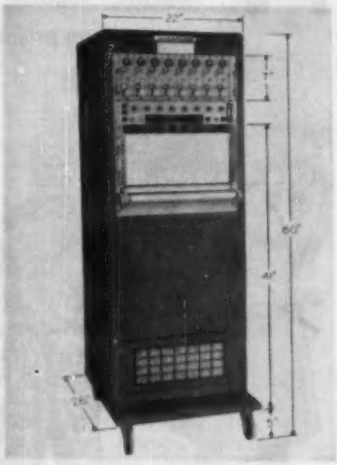
synchronous motors, and a variety of associated precision gear trains. All can be guaranteed to operate within ambients up to 200 C and are designed to give the maximum enclosure for protection against environmental conditions. **Circle 361 on Reader Service Card.**



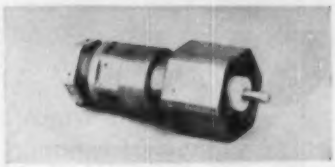
Recording Systems direct-writing

SANBORN CO., 175 Wyman St., Waltham 54, Mass. Six or eight interchangeable preamplifiers mounted in a single module in 7 in. of panel space and a recorder-power amplifier-power supply package permit extreme compactness in the new 850 series of direct-writing oscillographic recording systems. The 850's are especially suitable in applications of medium size d-c signals such as telemetry, analog computer readout and the like. A complete system is housed in a single cabinet 60 in. high. **Circle 362 on Reader Service Card.**

Magnetic Clutches single, double ended

PIC DESIGN CORP., 477 Atlantic Ave., East Rockaway, L. I., N. Y.,

offers a complete line of newly designed precision magnetic clutches in Mark 8 or Size 18 frame—1¾ in. in diameter. Both single and double ended units have been designed to offer a wider variety of application (¼ in. diameter shafts). All materials and finishes used are to military specifications. Specifications are 24-28 v d-c; power consumption, 3 w; output torque, 16 oz in. minimum. **Circle 363 on Reader Service Card.**



Cable Connector captive pin type

TAMAR ELECTRONICS, INC., 2339 Cotner Ave., Los Angeles 64, Calif. The 2075 captive pin connector is USAF approved for use with RG-117/U cable. Among the many advantages of this superior connector is the captivated center conductor and dimensionally stable Teflon dielectric. The slip nut feature allows complete mechanical insertion and good electrical contact prior to engaging the threads so that the nut may be easily rolled on and snugged into position. **Circle 364 on Reader Service Card.**

Pressure Transducer wide-range

BJ ELECTRONICS, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif., announces an extreme-range absolute-pressure Vibrotron transducer capable of converting input pressures of 0-1,000 psi into a direct electrical output in terms

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Full dress inspection

This Optical Comparator with magnifications up to 50 times provides an extremely accurate check on component parts dimensions – particularly those of complex hole relationships. And only those that meet the most rigid tolerances find their way into **Varian Klystrons** and **Wave Tubes**.

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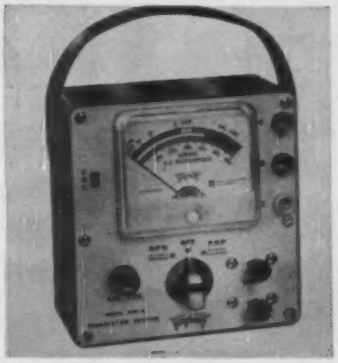
of frequency. Output of the unit is in the form of an audio (f-m) signal, with a frequency inversely proportional to applied pressure. Model 8815 is readily adaptable for applications in aircraft and missiles, as well as military or industrial ground equipment, and as a component in instrumentation and systems. High accuracy, linearity, ruggedness, and environmental stability are claimed. **Circle 365 on Reader Service Card.**



Transistor Tester simply operated

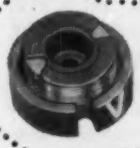
THE TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, Ohio. Model 690-A provides positive leakage and gain tests for *pnp* and *npn* type transistors. It measures d-c beta from 5 to infinity. A better indication of the degree of quality is made possible by the long GOOD portion of the scale. The tester also affords an exact test for shorts and leakage; and checks forward and reverse leakage of diodes. It features single switch selection of transistor types for operation simplicity. **Circle 366 on Reader Service Card.**

Cathode Ray Bulbs high temperature

CORNING GLASS WORKS, Corning, N. Y., has available cathode ray bulbs made of optical quality high temperature alumina-silicate glass. Virtually free of physical imperfections, the bulbs are particularly applicable to high resolution radar surveillance systems. Alumina-sili-

now
you can wind your filter coils
WITHOUT CORE ADJUSTMENTS
on
pre-adjusted filter cores

Typical Ferroxcube pre-adjusted pot core and bobbin.



Bobbin, wound with specified number of turns of wire for desired inductance, placed in pot core.

Assembly completed by placing second core over bobbin-and-core subassembly. Pot core aligned to within ±1% inductance by lining up V segments so that they form an unbroken V.

- guaranteed effective permeabilities within ±3%, ±2% or ±1% of specifications, instead of usual 10% to 50% spread
- measured, adjusted and grouped for magnetic characteristics at the factory
- a complete line of pot-type ferrite cores from ⅝" to 1¾" diameter, with bobbins and hardware for each size
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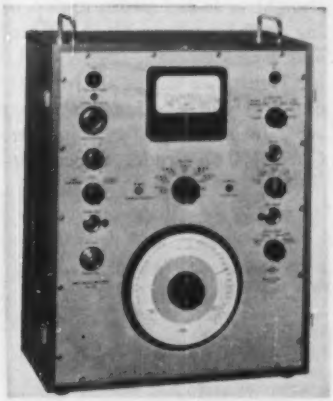
Saugerties, N. Y.

CIRCLE 240 READERS SERVICE CARD

cate glass can be optically melted. Flaws can be held to 0.001 in. or less in size. The glass withstands tube processing and/or operating temperatures up to 700 C. **Circle 367 on Reader Service Card.**

Program Timer handles 16 functions

Hub-Pot, Inc., 13827 Saticoy St., Van Nuys, Calif. Model 100 program function timer is designed for missiles, aircraft and ground checkout applications. It can handle up to 16 separate functions and is available with interchangeable switch, linear pot, and nonlinear pot function strips. It is designed to meet MIL-E-5272 specs. Driving motor of the timer can be stopped or reversed at any point. **Circle 368 on Reader Service Card.**



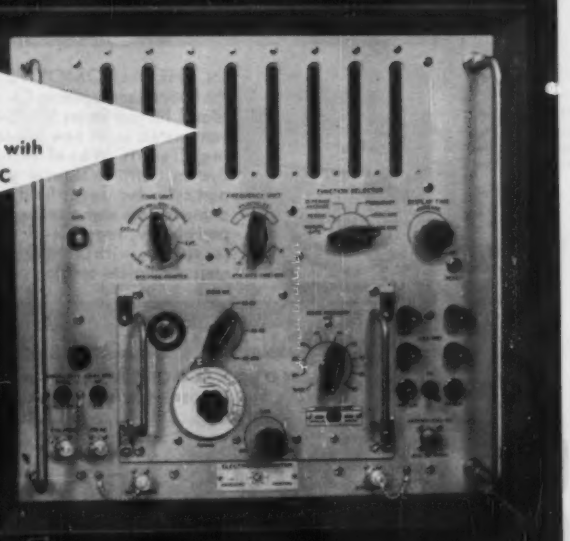
Spectrum Analyzer features true rms

B&K Instruments, Inc., 3044 W. 106th St., Cleveland, Ohio, is marketing for Bruel & Kjaer, Denmark, a new a-f spectrum analyzer featuring true rms, average, and

For Frequency Measurement, Counting, Periods, Time Intervals . . .

ELECTRONIC COUNTERS

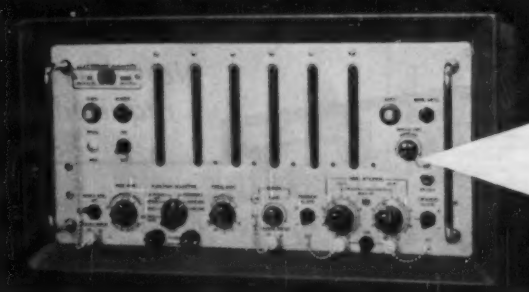
MODEL 14-20A
$1,700
10 cps to 10 MC with Plug-ins to 220 MC



NEW– Advanced Circuitry

NEW– Mechanical Design.

NEW HIGHS in STABILITY and ACCURACY
Yet at New LOWS in COST!



MODEL 13-20
$995
10 cps to 1.1 MC

BOTH MODELS available with optional Transistorized Oscillator: Stability 5 parts in 10^8 per week; and 5 parts in 10^8 per month thereafter; at nominal additional cost.

NORTHEASTERN ENGINEERING, INC.
MANCHESTER, N. H. • 25 So. Bedford St.
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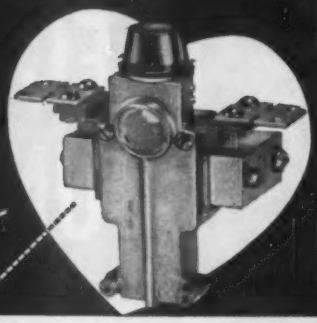
Make a GM PORTABLE D'ARSONVAL
GALVANOMETER
the Heart of Your Instrument



IN THE AUTOMOTIVE FIELD, the Bear Manufacturing Co. of Rock Island, Ill. uses Series 500 G-M Galvanometers in its new remote-reading Electric Wheel Alignment System (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

GM LABORATORIES • INC.
4336 NORTH KNOX AVE., CHICAGO 41
CIRCLE 242 READERS SERVICE CARD

CHECKS OUT TRANSISTOR CIRCUIT DESIGNS—in minutes!

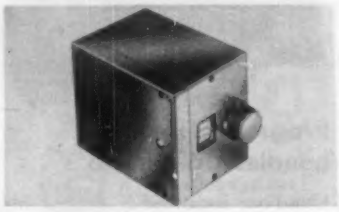
N.E.L. 525
TRANSISTOR CIRCUIT SYNTHESIZER

No soldering required!

- ✓ Pre-tests, evaluates transistor circuits
- ✓ Saves time, money, material
- ✓ No wiring
- ✓ No soldering
- ✓ No costly "breadboard" techniques
- ✓ Four transistor stages
- ✓ Flexible — allows Common Base, Common Emitter, Common Collector circuit configurations

For complete information, write
NATIONAL ELECTRONICS LABORATORIES, INC.
1713 KALORAMA ROAD, N.W., WASHINGTON, D. C.
a subsidiary of Thiokol® CHEMICAL CORPORATION
●Registered Trademark of Thiokol Chemical Corp. for its liquid polymers, synthetic rubbers, rocket propellants, plasticizers, and other chemical products.

peak readout, switch selected. It is of the ⅓ octave type with center frequencies ranging from 40 to 32,000 cps. Characteristics of the 30, ⅓ octave filters are: tops flat within ± ½ db; steep sides with maximum slope of 120 db per octave; skirt selectivity greater than 50 db per octave and greater than 70 db per 2 octaves from the center frequency. **Circle 369 on Reader Service Card.**



Precision Pot slidewire-tape

HOWELL INSTRUMENTS CO., 3101 Trinity St., Fort Worth 7, Texas, announces a new slidewire-tape potentiometer with direct digital readout of any linear or nonlinear calibration. It has a laboratory accuracy of 0.05 percent. The basic active element of the Ta'Pot H5600 is a resistance wire bonded within the edge of a laminated Mylar tape. The resistance wire may be either straight or in helical form, depending on the total resistance required, and is available in lengths of 120 in. Resistance ranges are from 100 ohms to 100 K. Case dimensions are 2 in. by 2¼ in. by 2¾ in. deep. **Circle 370 on Reader Service Card.**

Oscillator sinusoidal type

SOLID STATE ELECTRONICS CO., 8158 Orion Ave., Van Nuys, Calif. Model S-100 silicon transistor sinusoidal oscillator is an epoxy encapsulated unit designed to create a

STODDART

COAXIAL ATTENUATORS AND TERMINATIONS

made with exclusive Stoddart Filmistors for highly accurate and stable resistive values from dc to 3000 mc.

2, 6 and 10-position
TURRET ATTENUATORS
with simple "PULL-TURN-PUSH" operation, small and rugged.

Protected under Stoddart Patents

ATTENUATOR PADS

Available in any conceivable combination of male and female Type C and Type N connectors. Maximum length of 3" for any attenuation value.

GENERAL SPECIFICATIONS
VSWR: Less than 1.2 to 3000 mc.
Characteristic Impedance: 50 ohms.
Attenuation Value: Any value from 0 db to 60 db including fractional values.
Accuracy: ±0.5 db; values above 50 db have rated accuracy of attenuation through 1000 mc only.
Power Rating: 1.0 watt sine wave.

COAXIAL TERMINATIONS

Small-stable-50 or 70 ohms

½-Watt: 50 ohms impedance, TNC or BNC connectors, dc to 1000 mc, VSWR less than 1.2.

1-Watt: 50 ohms impedance, dc to 3000 mc or dc to 7000 mc, Type N or Type C connectors, male or female; VSWR less than 1.2, 70 ohm, Type N, male or female terminations available.

Fast delivery on all items.
Send for complete literature.

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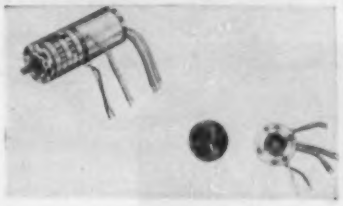
AIRCRAFT RADIO CO., INC.
6644 Santa Monica Blvd., Hollywood 38, Calif.
HOllywood 4-9292 .

CIRCLE 244 READERS SERVICE CARD

sine wave signal source. Stability as a function of supply voltage and temperature have been emphasized together with rugged reliability. The microminiature design is the result of careful small component selection, with stability a prime consideration. The oscillator is ideal for military, missile, industrial and portable applications. **Circle 371 on Reader Service Card.**



Motor-Generator has o-d of 0.750

G-M Laboratories, Inc., 4300 N. Knox Ave., Chicago 41, Ill., announces a new size 8 motor-generator. The tachometer-generator portion can be furnished for operation on either 18 or 26 v, 400 cps. It has a gradient of 0.250 v per 1,000 rpm and a maximum null voltage of 0.010 v rms. The motor portion can be furnished with any combination of voltages up to 40 v on both the fixed and control phases, all 400 cps. Stall torque is 0.3 oz-in., with a no-load speed of 6,200 rpm. **Circle 372 on Reader Service Card.**

Waveguide Waterload power absorbing

Bomac Laboratories, Inc., 1 Salem Road, Beverly, Mass., has developed a broad-band power absorbing waveguide waterload, BL-570. This load is capable of absorbing up to 400 w of c-w power over the frequency range of 4.95

COOL YOUR INSTRUMENTS

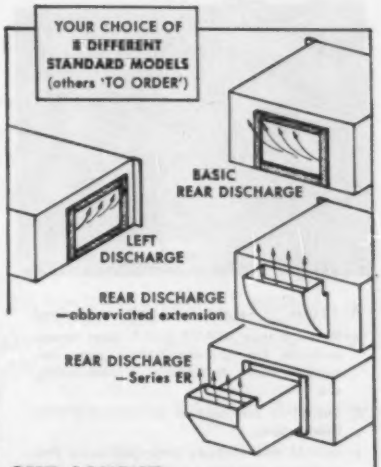
EXACTLY WHERE NEEDED

PANEL MOUNTING BLOWERS

MODEL BA-TF
with Top Front outlet
NOTE: Top Center and Top Rear also available

- **MIL SPEC QUALITY**
  Meet radio interference requirements of MIL-I-16910A
- **LARGE COOLING CAPACITY**
  600—1200 CFM output
- **COMPACT SIZE**
  Mount as standard 8¾" RETMA panel—15" front-to-back
- **CLEANABLE FILTER**
- **AIR DISCHARGE AREAS**

TO SUIT NUMEROUS APPLICATIONS: Vertical Printed Circuit Cards, Horizontal-mount Chassis, Vertical-mount Chassis, etc.


YOUR CHOICE OF 8 DIFFERENT STANDARD MODELS (others 'TO ORDER')
BASIC REAR DISCHARGE
LEFT DISCHARGE
REAR DISCHARGE —abbreviated extension
REAR DISCHARGE —Series ER

ONE SOURCE...

for VENTILATED RELAY RACK CABINETS, CONTROL CONSOLES, BLOWERS, CHASSIS, 'CHASSIS-TRAK'*, RELATED COMPONENTS

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WESTERN DEVICES, INC.
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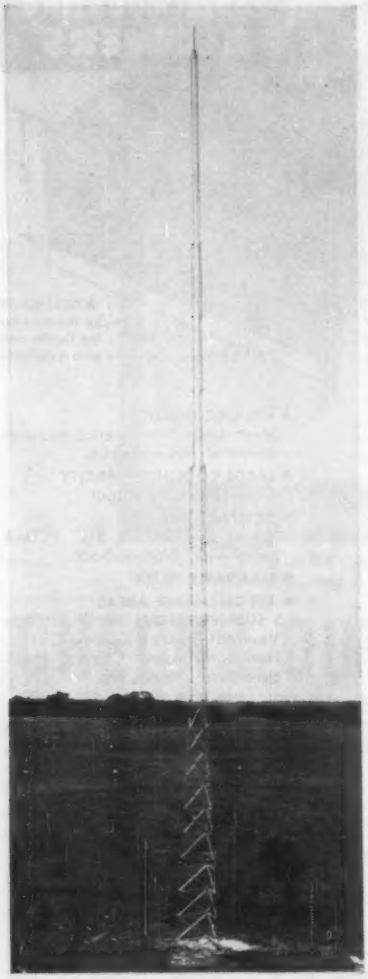
* *For Inquiries on 'Chassis-Trak', East of Rockies* Chassis-Trak Corp., 525 S. Webster Ave., Indianapolis

CIRCLE 245 READERS SERVICE CARD

New ROHN
SELF SUPPORTING
COMMUNICATION TOWER



★ 120 ft. in height, fully self-supporting!
★ Rated a true HEAVY-DUTY steel tower, suitable for communication purposes, such as radio, telephone, broadcasting, etc.
★ Complete hot-dipped galvanizing after fabrication.
★ Low in cost—does your job with BIG savings—yet has excellent construction and unexcelled design! Easily shipped and quickly installed.

FREE *details gladly sent on request. Representatives coast-to-coast.*

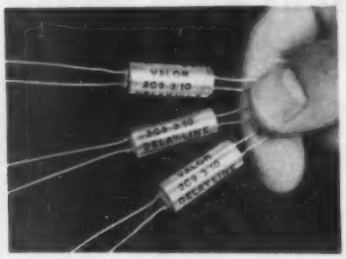
ROHN *Manufacturing Co.*
116 Limestone, Bellevue, Peoria, Illinois

"Pioneer Manufacturers of Towers of All Kinds"
CIRCLE 246 READERS SERVICE CARD

kmc to 10.5 kmc, and the vswr is under 1.20 over this range. This represents a reflected power of under 1 percent. This load may be used with any water-circulating system capable of supplying approximately 0.3 gpm at 6 psig. **Circle 373 on Reader Service Card.**

D-C Amplifiers miniaturized

NETWORKS ELECTRONICS CORP., 14806 Oxnard St., Van Nuys, Calif. A new series of miniaturized d-c amplifiers having adjustable voltage gains of 100 to 500, with a linearity of ± 0.5 percent, based on a 5 v d-c nominal output value, are announced. The units have been designed primarily for telemetry devices, guided missiles, and other uses where space and weight are a premium. They weigh approximately 7 oz and measure 2.5 in. by 1.19 in. sq. **Circle 374 on Reader Service Card.**

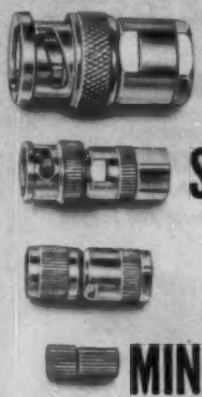


Delay Lines subminiature

VALOR INSTRUMENTS, INC., 13214 Crenshaw Blvd., Gardena, Calif. Precision lumped constant delay lines suitable for transistor and printed circuit applications are offered in a new subminiature case size. These delay lines consist of subminiature powdered iron toroi-

Today's requirements call for miniaturization,

but...



HOW SMALL IS MINIATURE?

Automatic
MAKES THEM ALL!

Unit engineered to fit all available sub-miniature cables, AUTOMATIC'S Sub-Miniature Connectors are available in three types; BAYONET, PUSH-ON AND THREADED COUPLING.

Special receptacles available for printed circuit applications.

CHECK THESE FEATURES:
No special tools required for assembly. Foolproof clamping insures accurate alignment . . . positive contact . . . extra strong grip. Exclusive internal-parts design allows outside dimensions of connectors to remain constant regardless of cable dimensions.

For BAYONET, PUSH-ON and THREADED SUB-MINIATURE and MICRO-MINIATURE COAXIAL CABLE CONNECTORS, always specify AUTOMATIC. Our engineers are always ready to discuss your special requirements.

Write, wire or phone for free technical information.

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METAL PRODUCTS CORP.
317 Berry St., B'klyn 11, N. Y.
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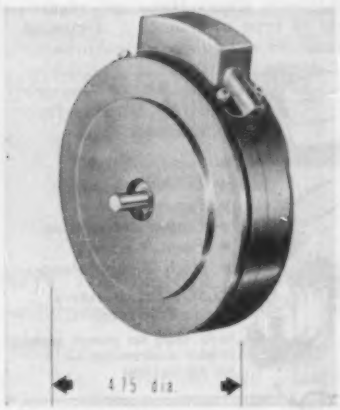
CIRCLE 247 READERS SERVICE CARD

dal inductors and temperature compensating ceramic disk capacitors in a lumped constant configuration which is phase and frequency compensated for optimum pulse response. Technical data are given in a recent bulletin. **Circle 375 on Reader Service Card.**



Compact Encoder 10-bit resolution

LIBRASCOPE, INC., 808 Western Ave., Glendale, Calif. Precise, multipositional reporting can now be accomplished with a new, miniaturized, 10-bit shaft position-to-digital encoder that features high resolution and eliminates ambiguity. Indicating wide application in computer control of automatic machinery, the new encoder translates analog shaft position to true binary digital information. Ten-bit resolution is obtained with only a 3½ in. disk that yields 1,024 discrete position representations per turn. The encoder's design permits the control of linear machine feeds to within tolerances of 0.001 in. of the total travel. **Circle 376 on Reader Service Card.**

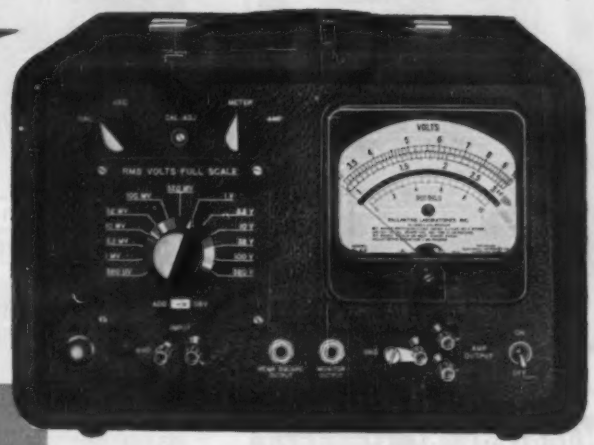
Oil-Filled Pots feature long life

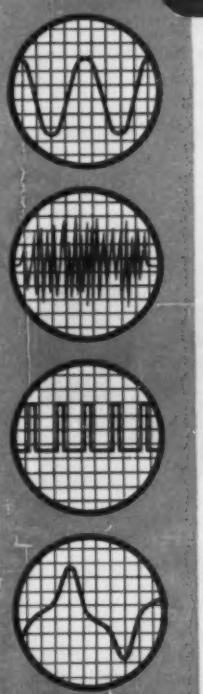
HELIPOT DIVISION of Beckman Instruments, Inc., Fullerton, Calif. Models 4203, 4613 and 4713 are high precision, multiturn potentiometers for servo mounting. All working parts are sealed in a bath of oil which effectively cushions

Now Measure

TRUE RMS

from 100 microvolts to 320 volts
REGARDLESS OF WAVEFORM
with the Ballantine Model 320 Voltmeter





REPRESENTING:

A distinctly new departure in VTVM design.

FEATURING:

A built-in calibrator; — easily read 5-inch log meter; — immunity to severe overload; — useful auxiliary functions.

BRIEF SPECIFICATIONS:

VOLTAGE RANGE: .....100 microvolts to 320 volts
DECIBEL RANGE: ..... — 80 dbv to +50 dbv
FREQUENCY RANGE: .....5 to 500,000 cycles per second
ACCURACY: .....3% from 15 cps to 150KC; 5% elsewhere
Figures apply to *all* meter readings
MAXIMUM CREST FACTORS: 5 at full scale; 15 at bottom scale
CALIBRATOR STABILITY: .0.5% for line variation 105-125 volts
INPUT IMPEDANCE: ....10 MΩ and 25 μμf, below 10 millivolts
10 MΩ and 8 μμf, above 10 millivolts
POWER SUPPLY: .....105-125 volts; 50-420 cps, 75 watt
Provision for 210-250 volt operation
DIMENSIONS: (*Portable Model*) .....14⅜" wide, 10⅛" high, 12⅜" deep—Relay Rack Model is available
WEIGHT: .....21 lbs., approximately

PRICE: $425

Write for the New Ballantine Catalog describing this and other instruments in greater details.

BALLANTINE LABORATORIES, INC.

BOONTON, NEW JERSEY

CIRCLE 248 READERS SERVICE CARD

you need only one instrument!

WEINSCHEL

ATTENUATION CALIBRATOR

combines precision

1. BOLOMETER PREAMPLIFIER
2. PRECISE AUDIO SUBSTITUTION ATTENUATOR
3. AUDIO LEVEL INDICATOR

ATTENUATION RANGE: 30 db
ABSOLUTE ACCURACY: 0.1 db
RESOLUTION: 0.01 db
FREQUENCY RANGE: .020 to 90 kmcs
(limited by bolometer mounts)

for detailed specs write for catalog E-58

Weinschel Engineering
KENSINGTON, MARYLAND

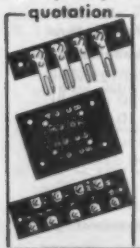
CIRCLE 261 READERS SERVICE CARD

Hundreds of standard

JONES TERMINAL PANELS

Complete equipment for SPECIALS

Send your specifications for prompt quotation



Several pages of Jones Catalog No. 21 illustrate standard and special panels we are constantly producing. Latest special equipment enables us promptly to produce practically any panel required. Send print or description for prices, without obligation. Hundreds of standard terminal strips also listed. Send for Catalog 22 with engineering drawings and data.

JONES MEANS Proven QUALITY

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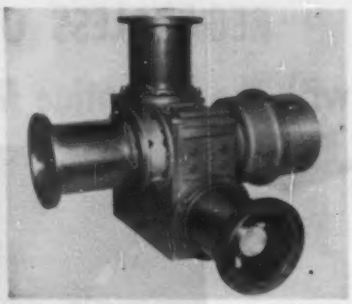
HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

CIRCLE 249 READERS SERVICE CARD

the unit against shock and vibration, protects it against environmental changes, increases dielectric strength, and flushes away wear particles that can reduce life and cause noise. Circle 377 on Reader Service Card.



Coaxial Switch 0 to 450 mc range

ALFORD MFG. CO., 299 Atlantic Ave., Boston, Mass. The type 1038 coaxial switch for 6⅛ in. coaxial transmission lines has a frequency range of 0 to 450 mc with a VSWR under 1.05. The c-w power rating is approximately the same as that of 6⅛ in. coaxial transmission line. Type 1038 is available in both motor-driven and manually-operated models. Circle 378 on Reader Service Card.

Linearizer for instruments

CUSTOM ENGINEERING AND DEVELOPMENT CO., 1429 S. Ewing Ave., St. Louis 4, Mo. The instrument linearizer model 110 is an electronic servomechanism which instantaneously and continuously corrects the output data of a nonlinear instrument and produces an output which is directly propor-

DANO COILS

INSURE HEALTHY ELECTRICAL PRODUCTS

Make sure your products have the exact coil specified by your design engineers. Every Dano coil, regardless of type or quantity, is custom made to exact specifications — just what the doctor ordered to insure healthy, trouble-free performance.

- *Encapsulated*
- *Bobbin*
- *Paper Interleave*
- *Cotton Interweave*
- *Form Wound*
- *High Temperature*

ALSO, Transformers Made-To-Order!

Write today for prompt analysis of your requirements — NO OBLIGATION!

DANO
THE DANO ELECTRIC CO.
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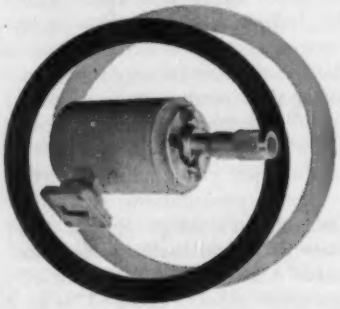
CIRCLE 262 READERS SERVICE CARD

D-B broad band gas-filled cavity wavemeters



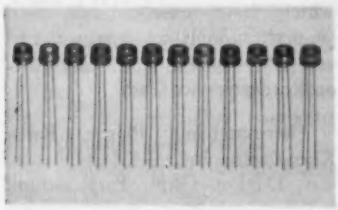
Each instrument covers a wide segment of the total range. Only 11 sizes serve from 2.6 KMC to 90 KMC. Accuracy is so high they may be used as secondary standards. Nitrogen filled and sealed for long life and high Q. Bi-metallic structure provides high degree of thermal compensation. Write for literature.

DE MORNAY BONARDI

780 South Arroyo Pkwy. • Pasadena, Calif.

CIRCLE 250 READERS SERVICE CARD

tional to the input to the nonlinear instrument. It was conceived to eliminate the time and labor of replotting nonlinear data before final interpretations can be made. Much time can be saved when families of curves must be processed or when it is necessary to integrate under a data curve. **Circle 379 on Reader Service Card.**



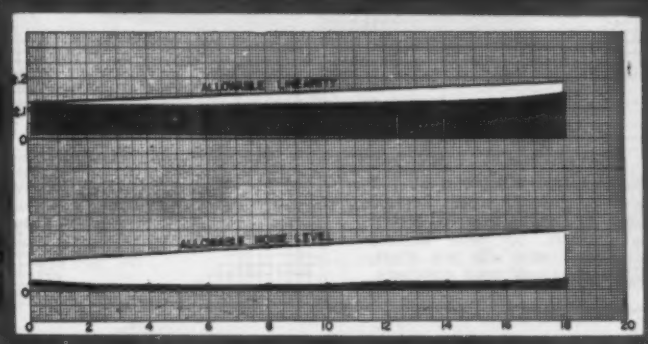
NPN Transistors switching type

CBS-HYTRON, Parker St., Newburyport, Mass., has introduced a line of *npn* transistors for high-speed switching and high-frequency amplification. The line comprises 12 computer types suited for logic-circuit and core-driver applications. These alloy-junction germanium units feature high current and voltage, flat gain, and low saturation resistance. They use a reliable, welded JETEC TO-9 package. Typical operating frequencies range from 4 to 12 mc, with maximum dissipations of 100 and 150 mw. **Circle 380 on Reader Service Card.**

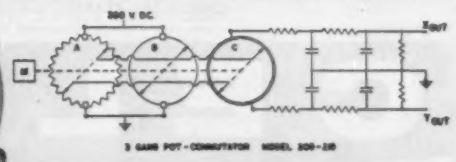
Compression Seals glass-to-metal

INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., 100 Kingsland Road, Clifton, N. J., has introduced a line of glass-to-metal compression seals for hermetically sealed relays, capacitors, magnetic amplifiers, transformers, toroids, semiconductor devices, and other hermetically sealed assemblies. The seals withstand extreme conditions of strain, vibration and thermal shock. Selected glass and alloys used in the manufacture are tested for a-c/d-c voltage rating, leaks and insulation resistance. The latter exceeds 100,000 megohms. **Circle 381 on Reader Service Card.**

With CARBON FILM POTS you get life of 18,000,000 revolutions



MILLIONS OF REVOLUTIONS AT 625 R.P.M.



PROBLEM

Airborne radar antenna mounted adjacent to rapid-fire guns rotates continuously at 625 rpm. Pot pick-off on mount indicates antenna position on a scope. Effective linearity of pot ±.12%. Ambients −73°C to 71°C, sea level to 60,000 feet, humidity, shock, vibration per MIL-E-5272A. Pot must operate to specs for 500 hours at 625 rpm, equivalent to more than 18,000,000 revolutions.

SOLUTION

Precision carbon film potentiometer ganged with C.I.C. commutator cups meet all performance requirements, with a life well beyond 18,000,000 revolutions at 625 rpm on production-line units.

The smooth surface of the carbon film combined with its natural lubricative properties insures long life at high speed. Wipers are not required to follow the contours of wire windings, therefore, wire very low brush pressures which enhance pot life, as wiper bounce occurs at high speeds.

The continuity of the resistance element does not depend upon a single hair-like wire. Failure of the potentiometer therefore does not occur suddenly, but any deterioration of performance is gradual. This fail-safe characteristic enhances reliability, and insures against catastrophic system failure at critical times.

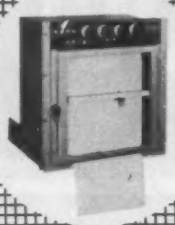
Your critical pot requirements can readily be met with C.I.C. Precision Carbon Film Pots and Commutators. We welcome your inquiries.

C I C COMPUTER INSTRUMENTS CORPORATION

THE MOSELEY

AUTOGRAF
trade mark

2 new recorders



MODEL 8
AUTOMATIC CHART
ADVANCE X-Y RECORDER

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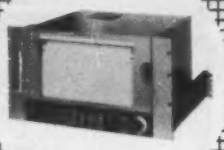

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Celco *Constantine Engineering Laboratories Co.*

Transistor or Vacuum tube drive.

Literature of

MATERIALS

Sealants and Molding Compounds. Coast Pro-Seal & Mfg. Co., 2235 Beverly Blvd., Los Angeles 57, Calif. A technical data chart describes polyurethane, Thiokol and silicone based electronic sealants and molding compounds which have excellent electrical properties, high temperature, fuel and cold flow resistance. **Circle 382 on Reader Service Card.**

Thermosetting Plastic Parts. Kurz-Kasch, Inc., 1421 S. Broadway, Dayton, Ohio. Parts design, material selection, mold making and compression or transfer molding services for custom molded thermosetting plastic parts are discussed in a 4-page, 2-color, illustrated folder. **Circle 383 on Reader Service Card.**

COMPONENTS

Selenium Rectifiers. Syntron Co., 241 Lexington Ave., Homer City, Pa. A four-page booklet gives complete listing of continuous d-c ampere current ratings for 26, 33, 36, 40, 45 and 52 v rms Syntron vacuum process selenium rectifier cells. **Circle 384 on Reader Service Card.**

Components. Kearfott Co., Inc., 1500 Main Ave., Clifton, N. J., has available new technical data sheets for insertion into its components catalog. They cover precision tachometers for integration, synchros and a dual channel transistorized buffer amplifier. **Circle 385 on Reader Service Card.**

Hybrid T's. Microwave Development Laboratories, Inc., 92 Broad St., Babson Park 57, Wellesley, Mass., has released a six-page, two-color catalog, No. 850, which provides an up-to-date guide for the selection of precision cast and fabrication E plane and H plane folded hybrid T's. **Circle 386 on Reader Service Card.**

Silicon Solar Cells. Hoffman Electronics Corp., Semiconductor

the Week

Division, 930 Pitner Ave., Evanston, Ill. A four-page brochure details the electrical and physical characteristics of the company's standard line of silicon solar cells. **Circle 387 on Reader Service Card.**

EQUIPMENT

Communications Tower. Rohn Mfg. Co., 116 Limestone, Bellevue, Peoria, Ill. A new catalog features full information on the company's line of heavy-duty communications and amateur towers. **Circle 388 on Reader Service Card.**

H-F Heating. Lepel High Frequency Laboratories, Inc., 55th St. & 37th Ave., Woodside 77, N. Y. Third issue of the *Review* contains many interesting applications and articles on h-f induction heating including a comprehensive article on temperature control. **Circle 389 on Reader Service Card.**

Environmental Chambers. Webber Mfg. Co., Inc., P. O. Box 217, Indianapolis 6, Ind. A 28-page brochure illustrates and describes a wide line of environmental chambers. Included are technical information, environmental applications and product applications. **Circle 390 on Reader Service Card.**

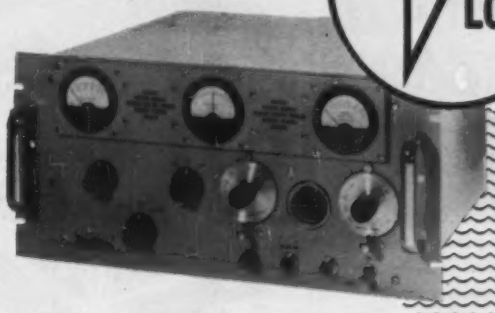
Frequency Shift Terminal Equipment. Northern Radio Co., Inc., 149 E. 22nd St., New York 11, N. Y. A complete line of frequency shift terminal equipment (34 items in all) is described in a 2-color 64-page catalog. Write on company letterhead for a free copy.

FACILITIES

Tantalum Capacitors. Transistor Electronics, Inc., West Road, Bennington, Vt. A well illustrated brochure contains information on the company's background and facilities for manufacturing tantalum capacitors. Performance characteristics for several types are given. **Circle 391 on Reader Service Card.**

Latest Addition to NEMS • CLARKE RECEIVER LINE

PHASE LOCK



Now available in the Nems-Clarke line of telemetry receivers is the 1400 Series employing phase-lock detection. The receivers are of the double super-heterodyne type with a noise figure of less than 8 db.

The primary advantages of phase-lock when used as a wide band receiver demodulator is a lowering of the receiver threshold and an overall improvement in signal-to-noise ratio.

Frequency ranges determined by plug in crystals

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Type 1430, 1431	225 to 260 mc
Type 1432, 1433	215 to 260 mc

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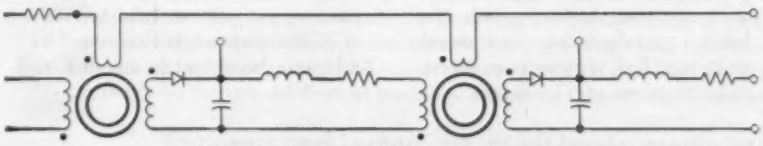

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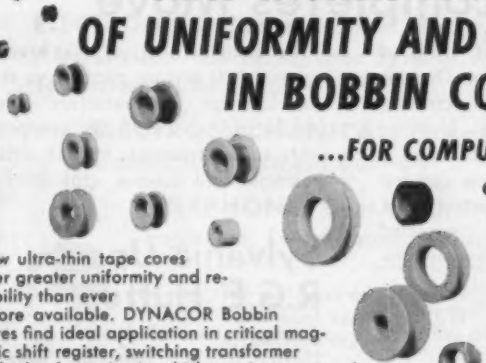

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ITT Builds New Tube Plant

CONSTRUCTION WORK is ahead of schedule in Roanoke, Va., on the new ultramodern tube plant of ITT Components Division of International Telephone and Telegraph Corp.

The new facility, a 58,000-sq ft building, will begin operating in January 1959.

Plant is being built on an 18-acre site and, together with the latest manufacturing equipment to be installed, represents an investment in excess of $3,500,000.

The plant will feature air-conditioned and dust-free assembly rooms, making it among the most modern tube manufacturing facilities in the world.

The new operation will be used for the production of traveling wave tubes, image storage tubes, and other special purpose tubes developed in ITT laboratories, expanding the present tube facilities of ITT Components Division. The division's headquarters are in Clifton, N. J.

Helipot Completes Move

BECKMAN INSTRUMENTS, INC., announces that its Helipot Division has completed transfer of personnel and equipment from Newport Beach to Fullerton, Calif., and is in full production in new quarters at the company headquarters plant. The 20-mile move was completed by stages to minimize loss in production time.

Transfer of Helipot was a step in Beckman plans to streamline its operations and achieve more efficient utilization of existing manpower and plant resources, according to company spokesmen. The Fullerton plant, recently expanded by 100,000 sq ft, now serves as headquarters for the company's Helipot International and Scientific and Process Instruments divisions, as well as the Beckman corporate staff.

Beckman's Fullerton plant houses some 1,600 persons engaged in the development, manufacture and marketing of electronic components and instruments for industrial, scientific and defense applications.

Sylvania Ups R.G.E. Hutter

APPOINTMENT of Rudolf G. E. Hutter as chief engineer, Special Tube Operations, Sylvania Electric Products Inc., Mountain View, Calif., has been announced.

In his new position, he will be responsible for the research, development and engineering activities of these operations centered in the Microwave Components Laboratories.

Hutter joined the company 14 years ago as a senior engineer in its Research Laboratories at Bayside, N. Y. There he has been section head in charge of microwave electronic research, engineering manager in charge of physical electronics development, manager of the Physics Laboratory, and associate director of research in physics.

Name Shepherd As Consultant

HEAD of the University of Minnesota Department of Electrical Engineering, William G. Shepherd, has been retained as consultant by Control Data Corp., Minneapolis, Minn.

In announcing Shepherd's association with his firm, William C. Norris, president, stressed the importance of research in meeting the challenge of the space age and pointed out that the new appointee will provide continuing technical counsel on advanced research for Control Data.

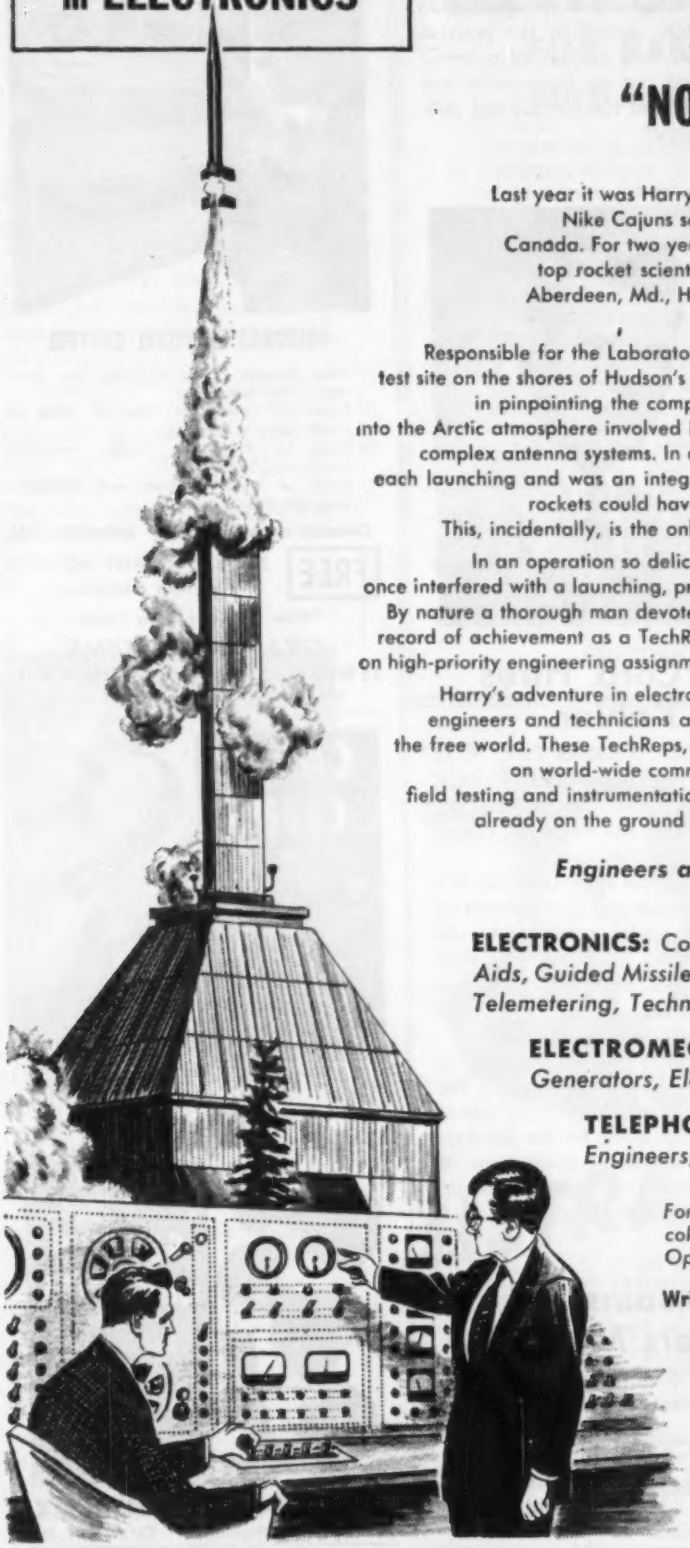
Leach Corp. Buys Engdahl Assets

ACQUISITION by the Leach Corp., Compton, Calif., of all assets of the Engdahl Enterprises of Arcadia, Calif., developer and manufacturer of electronic data instruments, was recently announced.

Paul Engdahl, founder of the firm and president, joins the Leach

ADVENTURES in ELECTRONICS

HARRY MORGAN, PHILCO TECHREP, SETS 'EM UP FOR THE "NOSE-CONE" SCIENTISTS



Last year it was Harry Morgan's final 'okay' that sent the Aerobees and Nike Cajuns screaming skyward at the IGY base in Ft. Churchill, Canada. For two years, working side by side with some of the nation's top rocket scientists at the Army's Ballistic Research Laboratory in Aberdeen, Md., Harry participated in the engineering and planning of this project from inception to completion.

Responsible for the Laboratory's range instrumentation during field trips to the test site on the shores of Hudson's Bay, all of Harry's resources were called into play in pinpointing the complete trajectory story of each rocket. These probes into the Arctic atmosphere involved intimate familiarity with DOVAP transponders and complex antenna systems. In addition, Morgan sat at one of the consoles during each launching and was an integral part of the countdown. Without his 'okay', no rockets could have left the pre-heated launching pad shown at left. This, incidentally, is the only completely enclosed launching platform known.

In an operation so delicate that a taxicab's radio signal in South Carolina once interfered with a launching, precise men such as Harry were absolutely essential. By nature a thorough man devoted to exacting work, Morgan has built an enviable record of achievement as a TechRep and has won a reputation for original thinking on high-priority engineering assignments at TechRep installations throughout the world.

Harry's adventure in electronics is not uncommon among the more than 3,000 engineers and technicians assigned to vital electronic installations throughout the free world. These TechReps, performing engineering and maintenance services on world-wide communications systems, early warning radar networks, field testing and instrumentation of offensive/defensive missiles and systems, are already on the ground floor of tomorrow's important adventures in space.

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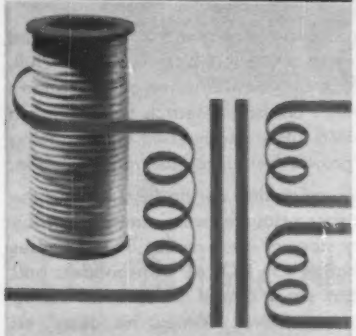

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administrative staff as manager of a newly formed Instrument Products Group.

The acquisition is expected to materially strengthen the position of Leach as a supplier of components and systems for missiles and satellites and commercial and military aircraft.

ESC Corp. Hires Emil Kohler

ESC Corp., Palisades Park, N. J., manufacturer of pulse transformers, delay lines and shift registers, appoints Emil Kohler to its design and development staff.

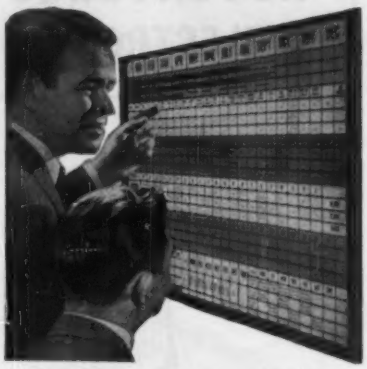
Kohler's new responsibilities will include design and development of electronic pulse components, including delay lines, magnetic shift registers and filters. He will also supervise the prototype section of the engineering laboratory.

He was formerly engaged in senior engineering functions for the Bogue Electric Mfg. Co., where he was responsible for the development of important innovations in the electromechanical, ultrasonic and semiconductor fields.

Shea Joins Waters Mfg.

Former quality control engineer and production chemist at the Somerville, Mass., plant of Ford Motor Co., John J. Shea recently joined the engineering staff of Waters Mfg., Inc., Wayland, Mass., manufacturers of potentiometers,

How To Get Things Done Better And Faster



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electrical components and electronic and mechanical instruments and test equipment. He will assist engineering in setting up new processes and production methods on new products.

TEC Appoints Sales Executive

TRANSISTOR ELECTRONICS CORP. of Minneapolis appoints Raymond C. Skoe as assistant sales manager of the company.

An electronic engineer, Skoe was at one time with International Business Machines at Endicott, N. Y. In 1951 he joined the staff of Remington Rand Univac in St. Paul as a computer designer and was active in the design of the Univac file computers.

Move Robertson To High Post

APPOINTMENT of G. D. Robertson as manager of the new advanced development engineering department for the government and industrial division of The Magnavox Co., Ft. Wayne, Ind., is announced. This department, under Robertson's direction, has been formed to facilitate the development and exploitation of recent scientific and technological advances and will conduct exploratory work on industrial and defense problems.

Since joining Magnavox in 1953, Robertson has served as staff engi-

ELECTRONICS MANAGER

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This department is currently engaged in research and development relating to aircraft and industrial instrumentation, air traffic control and computer devices. This technical executive will be expected to expand current research programs as well as initiate new research in the fields of commercial and military electronics. Salary is open and there are excellent liberal executive benefits.

Complete and detailed resume should be sent to: T. W. Cozine, Mgr., Executive & Technical Placement, Curtiss-Wright Corporation, Dept. RD-55, Wood-Ridge, N. J.

All resumes and contacts will be held in complete confidence.

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C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

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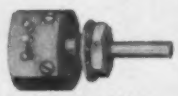
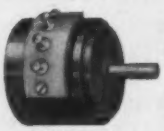


RVG-10 ⅝"



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nceer, chief sonar engineer, and section chief of communications and navigation.

Bendix Missile Promotes Wendt

APPOINTMENT of Robert R. Wendt as assistant quality manager of Bendix Products Division—Missiles was recently announced. In this capacity, he directly assists the quality manager in administering the test engineering, test and inspection, environmental test, test equipment design and reliability operations involved in the Talos missile program.

Prior to his new position, Wendt was chief engineer, test operations, with responsibility for directing missile and systems functional test in Talos production. He obtained extensive experience in environmental test work and missile reliability activities as project engineer in charge of the Environmental Test Laboratory and Reliability Department at the Mishawaka, Indiana, plant.

L.A. Firm Expands Eastward

TELECOMPUTING CORP. recently announced its first major expansion eastward, through the acquisition of the Frank R. Cook Co. of Denver, Colo. William R. Whittaker, president of the Los Angeles elec-

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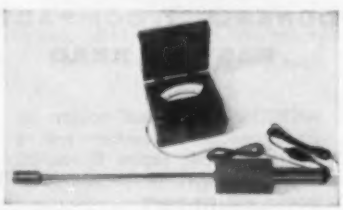

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FEATURES—Type 726:

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- Simple operating principles, simple to use and maintain.
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tronics firm, said the move will add additional systems capabilities to Telecomputing Corp., which is a principal manufacturer and subcontractor to industry and defense.

The Frank R. Cook Co. is known for its original design and manufacture of high-energy power sources for air and space borne applications.

News of Reps

Samco Mfg., Inc., Orange, N. J., manufacturers of precision tube forms and bends, and microwave-guides, appoints **James H. Lawrence** of Dallas, Texas, as rep for Texas, Oklahoma and New Mexico.

Precision Instrument Co., San Carlos, Calif., manufacturer of magnetic tape handling instrumentation has appointed three new reps:

Scientific Sales Engineering Co. with offices in Atlanta, Ga., and St. Petersburg, Fla., will handle the line in Georgia, North and South Carolina, Florida, Mississippi, Louisiana and Alabama.

Wild & Associates with offices in Roslyn, L. I., N. Y., and Arlington, Va., will cover New York State, eastern Pennsylvania, Virginia, Maryland, Delaware, New Jersey and Washington, D. C.

Hawthorne Electronics with offices in Portland, Ore., and Seattle, Wash., will serve Oregon, Washington, Idaho as well as western Canada.

Clevite Transistor Products, Waltham, Mass., appoints the **Robert E. Nesbitt Co.** of Dallas, Texas, as sales rep for Oklahoma and Texas (except El Paso County).

Nems-Clarke Co., Silver Spring, Md., has named two sales reps to handle its line of telemetry equipment and components:

D. B. Carey of Ft. Worth, Texas, will cover Texas and Oklahoma. **Scientific Sales Engineering Co.** of Atlanta, Georgia, is appointed for Georgia, Alabama, Mississippi, Tennessee, North Carolina, South Carolina, Virginia (Charlottesville and south).

☐ **NUCLEAR ENGINEERING HANDBOOK**

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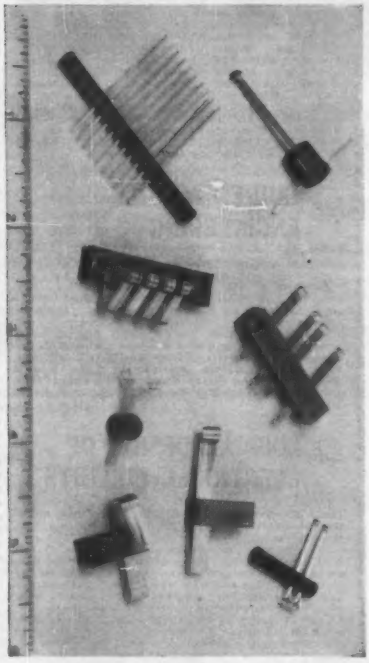

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NEW BOOKS

Electronic Semiconductors

By EBERHARD SPENKE.

McGraw-Hill Book Co., Inc., New York, 1958, 402 p, $11.00.

"The careful derivation of important relationships from precisely defined concepts and assumptions is one of the book's outstanding features." This quotation from the dust jacket of "Electronic Semiconductors" is an excellent characterization of the volume. Whether this makes the book good or bad, useful or not, depends on the level of the reader.

Spenke's book is ostensibly an elementary introduction to the "most easily understood, and yet precise" phases of the physics of semiconductors. To the engineer or physicist who wants to learn the fundamentals of this field, though, the book will be disappointing, mainly because Dr. Spenke takes such pains to avoid being imprecise that the overall coverage of a new idea becomes lost in a style of writing reminiscent of patent language.

As with patents, the language, the style, the exceptions are for the experts, whereas here the discussion is meant to be elementary. Continual references either to footnotes wherein exceptions to generalizations are discussed at a level of sophistication beyond that which the book itself presumes, or else to later chapters where a more careful treatment of a point under discussion is presented, serve mainly to disrupt the smooth development of the subject matter. One learns more about the exceptions to a given situation than about the situation itself.

Organization—The book is similar to the classic "Electrons and Holes in Semiconductors" by Shockley in that the subject matter in succeeding parts of the book is returned to and treated in a more refined manner.

There are other stylist points which present additional hurdles to the elementary reader. In many places (and it is a rare book with this fault) too many intermediate algebraic steps are included in the derivation of a particular equation.

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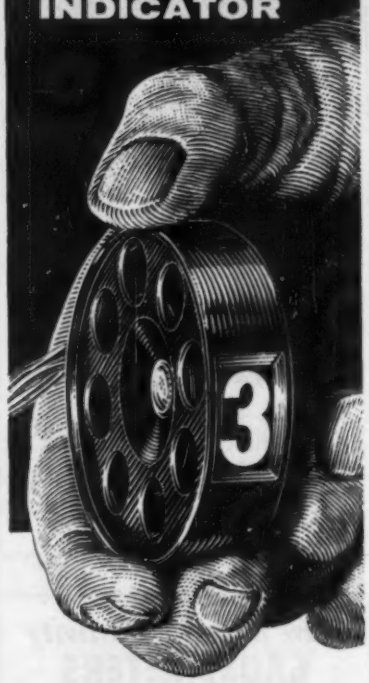

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who is quite familiar with the material, the book is well worth the trouble of reading. What the reader will gain is renewed awareness of the limits of validity of many of the concepts that one in general tends to take for granted. In addition, two important subjects are treated in a manner not readily found elsewhere. One is the approach to problems involving the rates of generation and recombination of carriers. This subject is discussed from the point of view of chemical kinetics and the law of mass action, which I feel is the proper way to introduce the material. Spenke's discussion should help clarify and unify the thoughts of one who has done some thinking along such lines.

The second excellent discussion is that relating to the Fermi level, its interpretation as an electrochemical potential and the relation of this to the equilibrium at a junction of, say, a metal and a semiconductor. It is the precision of the writing, but by no means the organization, that will make this discussion valuable to one who thinks he knows the material. It is a bit unfortunate, however, that the book was written before the current interest in thermoelectric devices since Spenke's treatment can so easily be extended to clarify cooling phenomena at junctions.—S. KOENIG, *IBM Watson Laboratory at Columbia University, New York, N. Y.*

Notes on Analog-Digital Conversion Techniques

Edited by ALFRED K. SUSSKIND.

MIT Technology Press and John Wiley & Sons, Inc., New York, 1957, 410 p, $10.00.

THIS book is an outgrowth of notes prepared for systems and design engineers undertaking an intensive, one-week survey course in the theory and design of analog-digital conversion techniques. The approach used in the survey was to present the systems aspects of digital information processing first, then proceed to a detailed engineering analysis and evaluation of a variety of conversion devices, finally providing case studies based

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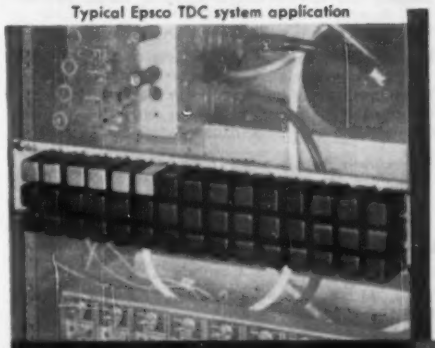

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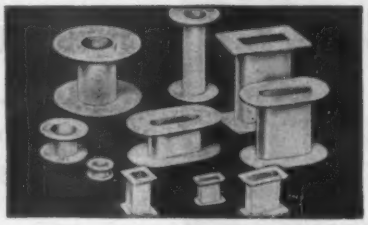

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on development work done at MIT Servo Mechanisms Laboratory.

The first three chapters are primarily of interest to the systems engineer, since overall system concepts are discussed here, including sampling, quantizing theory and coding. The use of numerous illustrations is to be commended, in particular, the technique of using a modified abacus, turned 90 deg. to show the derivation of the distribution function with graphic simplicity.

The chapters dealing with digital circuits and coding and decoding techniques are of special interest to circuit design engineers. The circuit chapter is comprehensive in its coverage and deals with the design philosophy of the basic electron-tube and magnetic circuits found in digital converters. Unfortunately, the material does not cover transistorized circuits; however, this fact does not negate the value of these chapters to the engineer seeking insight in this particular field. The chapter on coding and decoding techniques discusses in detail, circuits and techniques designed to convert analog voltages into digital signals including the staircase generator comparison technique.

The remaining chapters deal with specific forms of coders and decoders. The material covers a broad line of units from the purely electronic to the primarily mechanical form of device. The last two chapters deal exclusively with the problems and solutions encountered in designing a digital flight test instrumentation (DFTI) system.

Each chapter is well documented with up-to-date reference material making it easy for the reader interested in further information to proceed much deeper into the technology. The style of presentation is clear and concise making it relatively easy for the practicing engineer with little background on this topic to peruse the material and gain a worthwhile insight in the problems of analog-to-digital conversion.—J.M.K.

THUMBNAIL REVIEW

Permanent Magnet Handbook. Edited by E. M. Underhill, Crucible Steel Company of America, Advertising Dept., Box 2518, Pittsburgh 30, Pa.,

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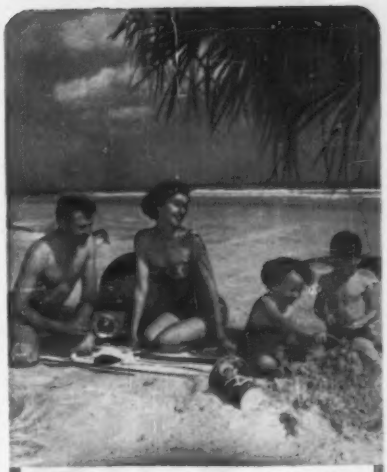
1957, 380 p, $10.00. Twelve color-coded sections in loose-leaf form include permanent magnet design and measurements, ferromagnetism and electromagnetic theory, magnetization and demagnetization. Specifications and data section presents nominal magnetic, physical and mechanical data as well as demagnetization curves, energy product values and other information for all important permanent magnet materials. Supplementary data sheets are sent to handbook owners.

Mathematical Foundations of Information Theory. By A. I. Khinchin, Dover Publications, Inc., New York, 1957, 120 p, $1.35. This rigorous exposition of the basic concepts of information theory places emphasis on the notions of entropy and channel capacity. Theorems of Shannon, McMillan and Feinstein are elaborated upon and new results relating to the capacity of channels with memory are derived. Familiarity with probability theory is essential for the understanding of the main ideas and detailed results.

Missile Engineering Handbook. By C. W. Besserer, D. Van Nostrand Co., Inc., Princeton, 1958, 600 p, $14.50. This fourth volume of the "Principles of Guided Missile Design" series contains data, which appears in the main series as well as in other unclassified literature, that will be of interest chiefly to mechanical or aeronautical engineers. The electronics engineer will find of value, however, the section on avionics and also the comprehensive glossary that comprises about one-third of the volume.

The Radio Amateur's Handbook. American Radio Relay League, West Hartford, Conn. 1958, 746 p, $3.50. This 35th edition of the Handbook has been revised and restyled in the light of current needs as a radio construction manual, reference work and training text for class or home study. Extensive material has been added on radio-teletype machine and circuits. The data chapter of vacuum tubes has been completely rewritten and rearranged. High power amplifiers and beam antennas have been added to the vhf sections.

Gaseous Conductors—Theory and Engineering Applications. By J. D. Cobine, Dover Pub., Inc., New York, 1958, 606 p, $2.75. Reprint of work first published in early forties covering physical concepts of kinetic theory of gases, atomic structure, ionization and emission phenomena in the first part; study of space charge, breakdown of gases and characteristics of spark, glow and arc discharges in the second part; engineering applications of discharge phenomena in the third part.



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COMMENT

Radar Nomograph

Re: Comment by (Joseph H.) Vogelman in your Oct. 10 issue (p 192) on near-zone measurements: according to calculations made in Vol. 12, MIT Radiation Lab series, the near zone is defined by $2D^2/\lambda$, not by $D^2/2\lambda$ as given in the referenced comment.

D. C. SMALL
JOHNS HOPKINS UNIVERSITY
SILVER SPRING, MD.

We referred this latest in a series of reader comments on the "Radar Power Nomograph," published on p 72 of our July 4 issue, to Author J. E. Allen, who replied:

The nomograph is based on far-field theory. Concerning the conservatism in power density as derived from the nomograph at distances in the near field, this safety margin was purposely allowed. It might be desirable to include a correction procedure for antenna-to-subject distances which are in the near field, because the attenuation of power from megawatt radars might otherwise appear prohibitive.

In the derivation of the correction procedure for use in the near field, it is shown that the near field extends to a distance of $0.734D^2/\lambda$ for purposes of determining average power density under conditions of use of the nomograph.

The values of $2D^2/\lambda$, $D^2/2\lambda$, and $0.25D^2/\lambda$ mentioned by other correspondents are probably all correct if used in the manner intended under the conditions for which they were derived. For example, if one were deriving the closest distance at which the far-field pattern could accurately be determined, he might arrive at the value $2D^2/\lambda$; whereas if one were deriving the greatest distance at which the aperture illumination pattern could be determined, he might arrive at the value $0.25D^2/\lambda$.

J. E. ALLEN
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Following is the derivation of the correction factor as provided by author Allen.

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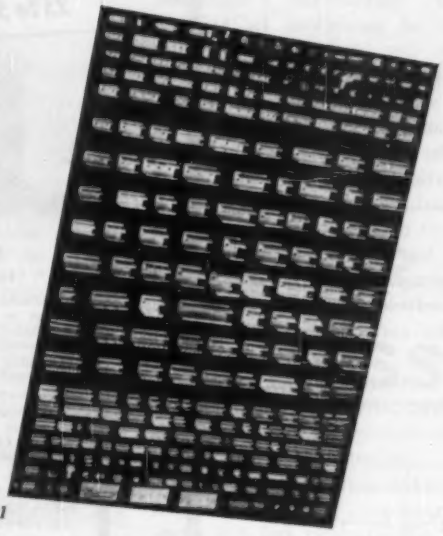

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hofer and Fresnel equations, it can be shown that the power-density ratio near-to-far is given by $(r\theta)^2/0.8D^2$. Substituting a reasonable value of paraboloid $1.22\lambda/D$ radians for θ produces a ratio $1.86r^2\lambda^2/D^4$, and equating this to 1 to solve for r produces a distance-to-transition $r_t = 0.734D^2/\lambda$.

The power ratio near-to-far for a particular radar can then be expressed as $(r/r_t)^2$. Converting this to decibels to derive a correction for the attenuation given by the nomograph, one finds
db = 10 log (ratio) = 20 log r/r_t.

The correction procedure then becomes:

1. Determine power density (or required attenuation) as indicated on the nomograph for any distance.

2. Compute the distance to which the near field extends from the equation $r_t = 0.734D^2/\lambda$, where D is dish diameter and λ is wavelength (expressed in the same units).

3. If r is greater than r_t, use values read from the nomograph.

4. If r is less than r_t, obtain corrected values by (a) multiplying the power density derived from the nomograph by $(r/r_t)^2$; (b) subtracting from the attenuation derived from the nomograph 20 log (r/r_t) db.

Frequency Divider

In Fig. 3 of my article ("Trigger Stabilizes Frequency Divider," p 104, Nov. 21), the capacitor between the plate of the pentode and its control grid should be 8,220 micromicrofarads. In the original drawing it was 1,250.

KUN-MU CHEN
HARVARD UNIVERSITY
CAMBRIDGE, MASS.

Big Horn

Is there an error of an order of magnitude in your Nov. 21 *Newsletter* (p 7) where you mention a horn antenna 844 ft long?

GEORGE FOLWELL
OMAHA, NEBR.

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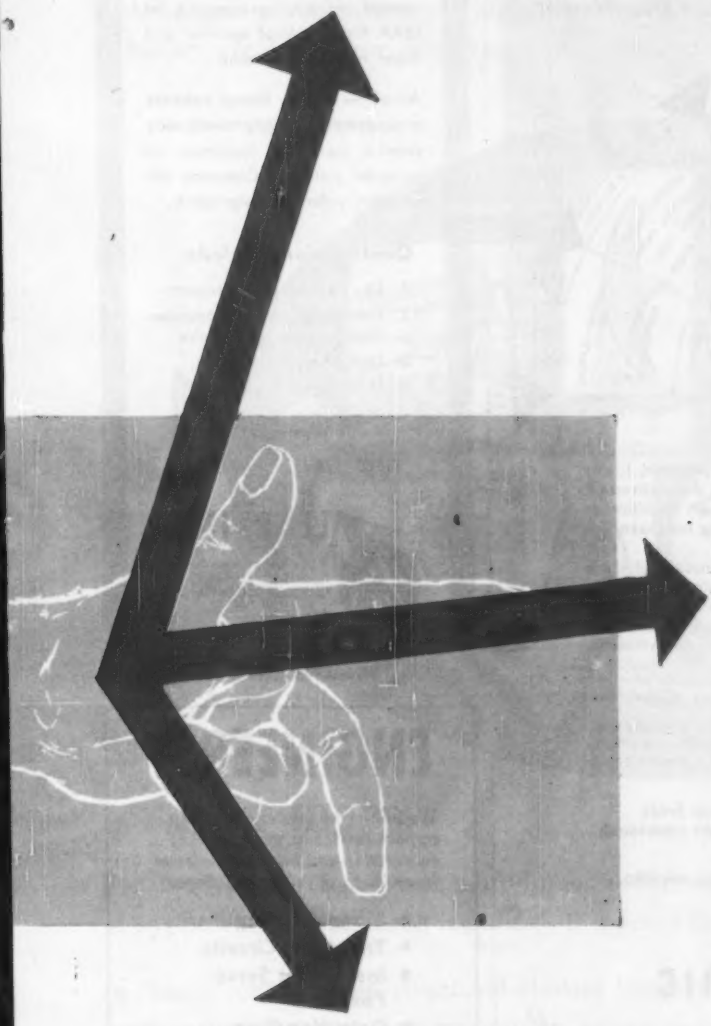

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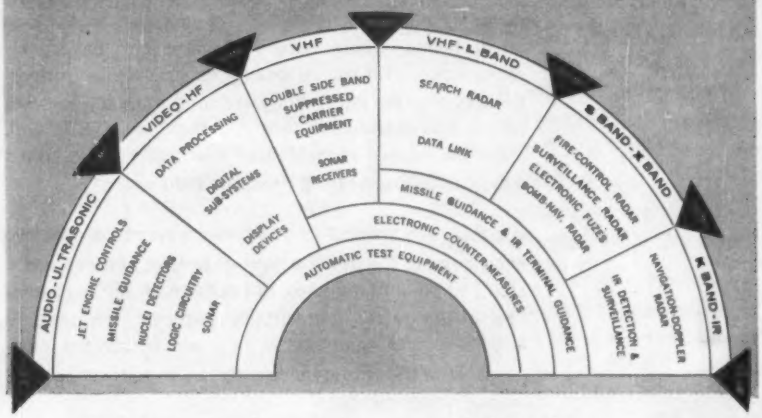

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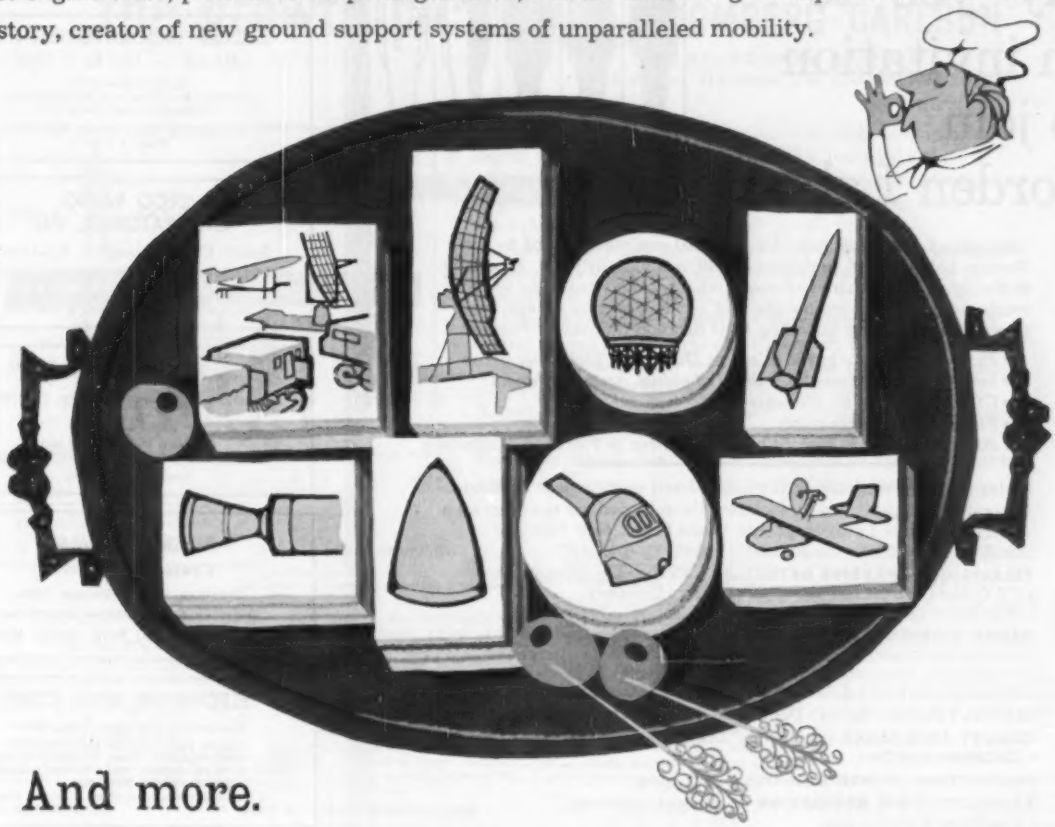

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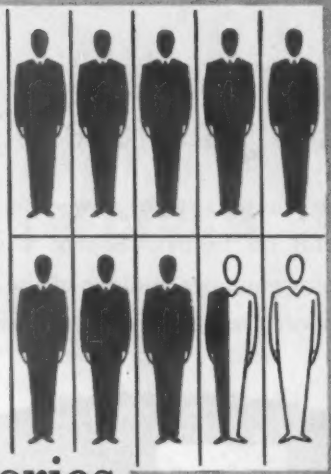

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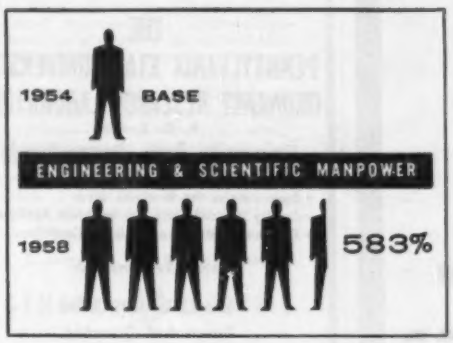

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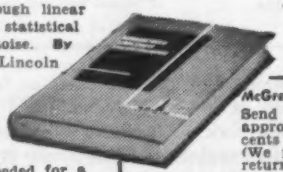

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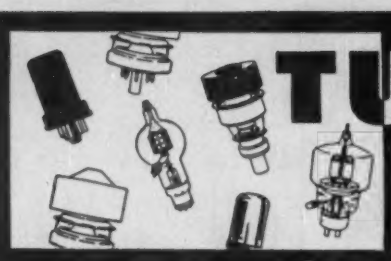

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0B2WA 2.00	2K26 34.50	5J31 4.00	FG-57 5.00
0B3/VR90 .70	2K28 30.00	5LP1 7.50	QK-57 Q
0C3/VR105 .45	2K33 100.00	5LP1A 20.00	QK-59 15.00
0C3W 2.00	3LP1A 100.00	5LP1B 15.00	QK-60 15.00
0D3/VR150 .40	2K40 100.00	5MP1 2.00	RK-60/1641 1.10
0D3W 2.00	2K41 100.00	5NP1 1.75	QK-61 15.00
1AE4 1.00	2K42 150.00	5R4GY 1.00	QK-62 15.00
1B22 .50	2K43 100.00	5R4WGA 4.00	HY65 .60
1B23 2.00	2K45 35.00	5R4WGY 2.75	FG-67 6.00
1B24 4.00	2K46 .195.50	5RP11A 65.00	HY-69 2.25
1B24A 10.00	2K47 100.00	5SP7A 40.00	72 .25
1B25 1.25	2K48 35.00	5SP2 65.00	73 .25
1B26 .85	2K50 .115.00	5SP2A 65.00	FG-81A 5.00
1B27 6.50	2K54 13.00	5SP7 65.00	FG-95 12.50
1B29 2.50	2K55 13.00	5SP11 50.00	BL96 200.00
1B35 .75	2K56 .100.00	5SP11A 50.00	FG97 25.00
1B35A 1.75	2N43 3.75	5SP11B 85.00	FG98A 28.00
1B37 2.00	2N132 Q	5SP9 85.00	BL-99 Q
1B40 12.00	2S/MR15 7.00	5V1WGT 1.50	
1B40 1.00	2X2 .25		
1B42 4.00	2X2A 1.00		
1B44 4.00	3AP1 1.50		
1B45 9.50	3ABP1 25.00		
1B47 2.50	3ABP2 28.00		
1B51 1.75	3BP1 15.00		
1B53 5.00	3BC4 1.50		
1B59/R1130B 12.00	3BP1 1.25		
1B62 1.75	3BP3 3.00		
1B63A 12.50	3B24 .50		
1N21B .80	3B24W 3.50		
1N23 .60	3B24WA 6.00		
1N23B .60	3B25 4.25		
1N23BM 2.00	3B26 2.50		
1N24 .60	3B27 6.00		
1N25 .75	3B29 4.25		
1N26 8.00	3CP1 3.25		
1N27 .80	3C22 27.00		
1N28 8.00	3C23 5.00		
1N31 2.50	3C24/24G 2.75		
1N32 2.00	3C27 .75		
1N34A .45	3C30 2.50		
1N48 2.50	3C45 4.50		
1N41 .60	3C45 6.00		
1N42 6.00	3DP11A 5.00		
1N46/400D .50	3DP21A 7.50		
1N47 1.00	3E29 2.00		
1N52 .40	3FP7A 2.00		
1N53 1.25	3JP1 1.00		
1N56 .60	3JP7 6.00		
1N56 .90	3J30 20.00		
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1P39 1.20	4C28 15.00		
1Q6 Q	4C32 15.00		
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2C40 6.00			
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2C53 8.75			
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2E22 2.50			
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2E32 1.00			
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QK-284A 200.00	FP-285 Q	714A 7.00	714A 7.00
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WE-287A 2.00	WE-289A 7.00	715C 10.00	715C 10.00
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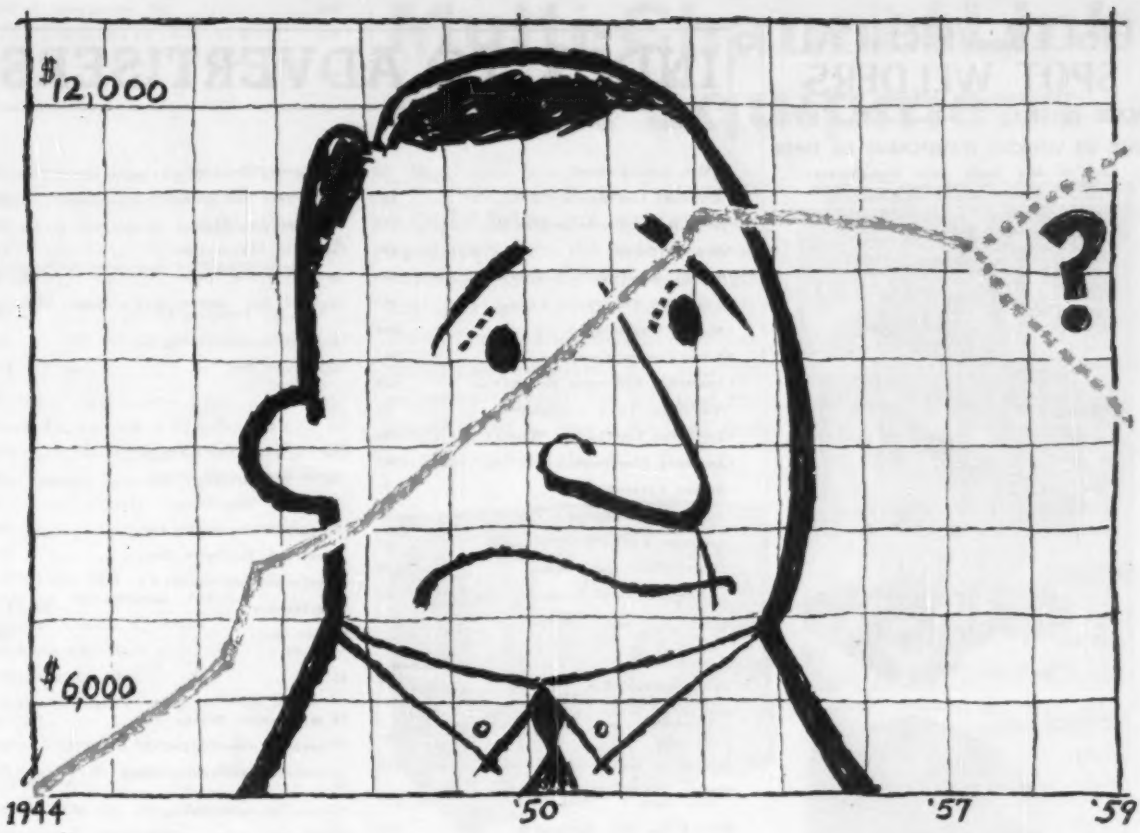

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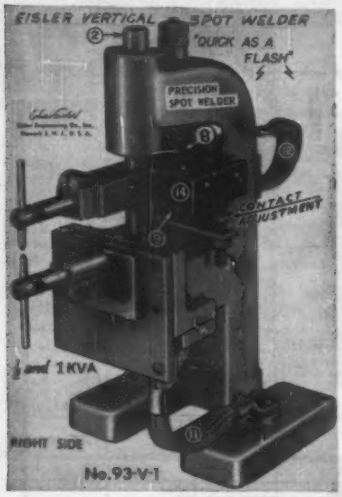

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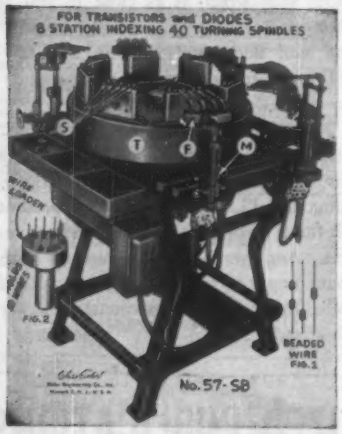

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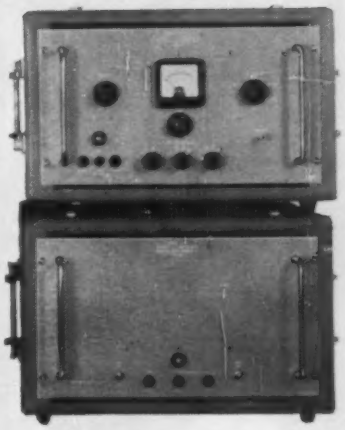

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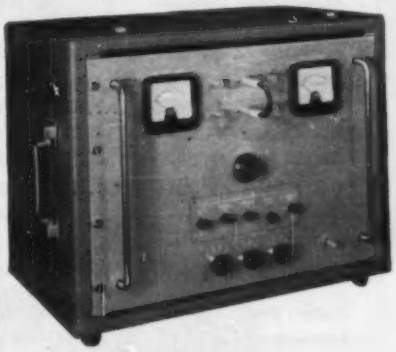

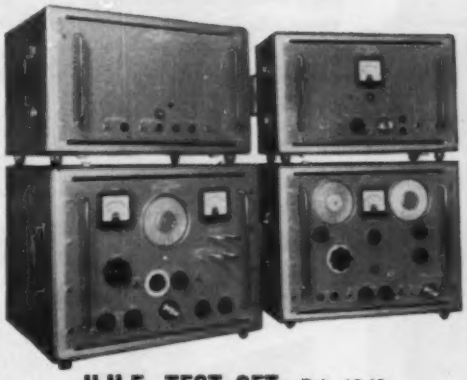

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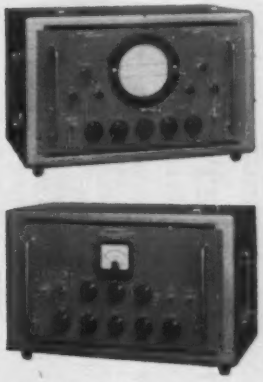

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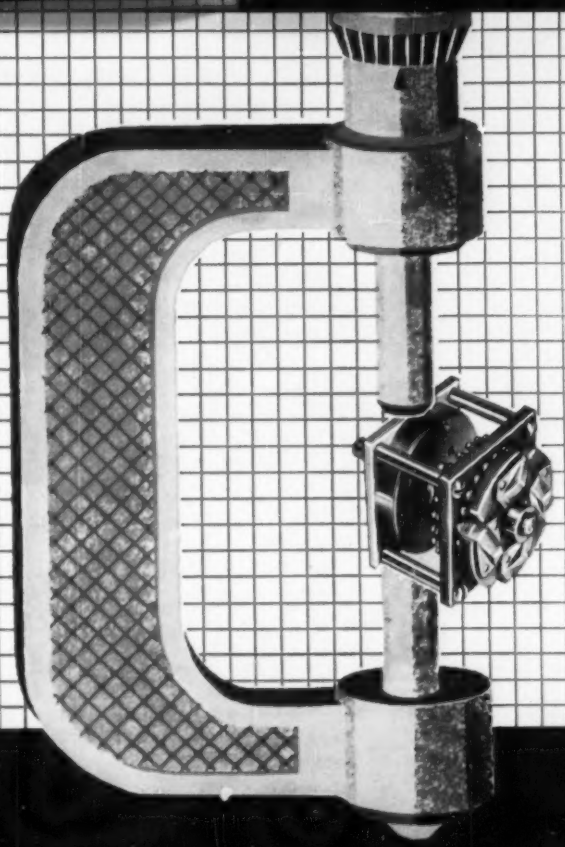
This index is published as a service. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

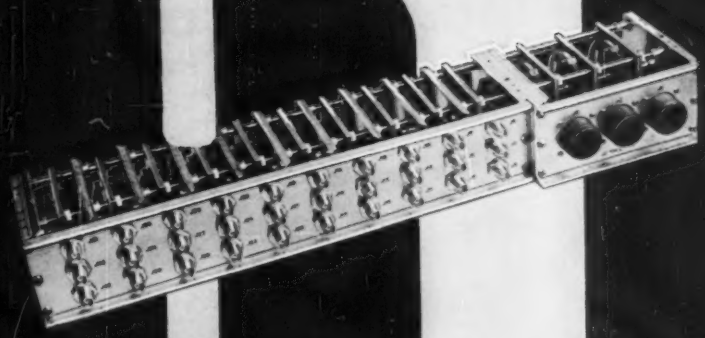
CORRECTION

The correct address of **THE DAVEN COMPANY** *is:* 528 West Mt. Pleasant Ave., Livingston, N. J.

The address in the **Daven** advertisement appearing on the inside back cover, the Nov. 7, 1958 issue of **Electronics** is the old and former address of **The Daven Co.** When writing to **Daven**, please use the Livingston, N. J. address.



everyone knows DAVEN makes switches like these...



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